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A RAND NOTE

ALEC: A Model for Analyzing the Cost-Effectiveness
of Air Force Enlisted Personnel Policies
(Theory and Results)

C. Peter Rydell

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Volume I

The Aggregate Lifecycle Effectiveness and Cost (ALEC) model enables managers of Air Force enlisted personnel to compare the cost effectiveness of alternative management actions for a part of the force selected for analysis. Example actions are limits on the numbers of various types of enlistments, reenlistment bonuses designed to increase the number of persons making the Air Force a career, retraining programs that transfer personnel from one specialty to another, and the early-release program. ~~This volume~~ gives the theory and behavioral relationships used to build the model and gives cost-effectiveness results. (See also N-2629/2.)

Often a variety of actions (or combinations of actions) are available to achieve a particular force management objective. Because ALEC is a microcomputer model that is easy to operate and that focuses on a (user-selected) part of the enlisted force, the model enables enlisted force managers to quickly reduce a set of alternatives to a short list containing those that are most cost effective in a given situation.

The analysis is presented in two volumes; the first explains the theory behind the model and the second documents the model itself.

Volume 1, *ALEC: A Model for Analyzing the Cost Effectiveness of Air Force Enlisted Personnel Policies (Theory and Results)*, N-2629/1-AF, gives the theory and behavioral relationships used to build the model and reports the results of using the model to compare the cost effectiveness of management actions for highly aggregated parts of the force.

Volume 2, *ALEC: A Model for Analyzing the Cost Effectiveness of Air Force Enlisted Personnel Policies (Documentation and User's Guide)*, N-2629/2-AF, presents the microcomputer model that estimates the cost effectiveness of management actions for a given part of the enlisted force. Users of the model can evaluate more complex combinations of actions and examine more specific parts of the enlisted force than Vol. 1 does.

A microcomputer disk will be included with Vol. 2. on request. The disk contains the ALEC model and the ALEC database (which currently reflects the Air Force specialty structure as of the end of fiscal year 1984). In addition to the microcomputer disk, the ALEC model requires a microcomputer installation that has an IBM PC compatible computer with 640 K memory, a graphics card, a printer, and the Symphony spreadsheet program from the Lotus Development Corporation.

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SUMMARY

The Aggregate Lifecycle Effectiveness and Cost (ALEC) model estimates the cost effectiveness of alternative management actions that the Air Force uses to control its enlisted force. Users of the model choose which part of the enlisted force to analyze and which combinations of management actions to test. The model then estimates the ratio of incremental cost caused by the action to the incremental effectiveness caused by the planned actions. Both the cost and effectiveness components of this ratio are the net present values over the lifecycle of the cohort affected by the actions. In the case of a plan that decreases force size, the ratio indicates the savings obtained per unit of effectiveness lost.

The effectiveness measures used in the analysis are based on the trained-person-year. This fundamental unit of effectiveness is then adjusted to account for the fact that senior personnel are worth more than junior personnel. The adjustment is done by valuing experience (time in the enlisted force) in proportion to how much pay increases with experience. The proportionality constant varies from zero (indicating that all trained-person-years are of equal value), through one (indicating an average value of experience), to two (indicating that productivity increases with experience twice as fast as pay does).

The model reports cost effectiveness results for the entire range of values of experience. The user of the model must decide which part of the value of experience range most adequately reflects conditions in the specialty being analyzed. This judgment is sometimes very easy, as the decision among alternative plans often remains the same over a wide range (sometimes the entire range) of the value of experience.

The current version of ALEC can analyze the following types of management actions: accessions, retraining, selected reenlistment bonuses, early releases, and Career Job Reservations. All these actions are ones over which the Air Force has discretion, and that the Air Force currently uses to guide the enlisted force.

ALEC is not set up to evaluate actions that the Air Force does not control, such as educational benefits, pay scales, and retirement benefits; although the effect of current levels of these actions is comprehended by ALEC's behavioral equations. Nor is ALEC set up to analyze actions that are not currently used to guide the enlisted force to any significant extent, such as accession bonuses or separation payments. Moreover, ALEC cannot analyze promotion policy. Omitting the grade dimension is the price that was paid to obtain a model that would run rapidly on a microcomputer.

The analyses in this volume illustrate the kinds of conclusions that can be obtained by using the model. The results here are suggestive rather than definitive. Nevertheless, the following conclusions are supported by the analyses to date, and they appear likely to hold up under future, more detailed analyses by model users.

To improve the cost effectiveness of the enlisted force:

- Avoid using "Zone C" (third term) reenlistment bonuses. The force increases that they generate cost 1.5 to 3.0 times more than necessary.

- Avoid early releases of personnel (before the end of their term of enlistment). Early releases generate only 65 to 85 percent as much savings as reducing force size by cutting enlistments.

- Use the remaining management actions that increase the senior force (prior service accessions, retraining-in from other specialties, and reenlistment bonuses) in specialties that have high values of experience or that have average values of experience and high training requirements.

- Use the remaining management actions that decrease the senior force (retraining-out to other specialties and Career Job Reservations) in specialties that have low values of experience or that have average values of experience and low training requirements.

The general conclusions about actions that increase and decrease the force apply in particular to management of the zone A reenlistment bonus and the CAREERS programs that affect the flows from initial enlistment specialties to the specialties in which enlisted personnel will spend the rest of their Air Force career. These programs are the two most important shapers of the enlisted force. The key point to recognize, from the viewpoint of cost effectiveness, is that either a specialty should be offered a zone A bonus or it should have Career Job Reservations for reenlistees from other specialties.

- Offer the zone A reenlistment bonus to specialties that have high values of experience or that have average values of experience and high training requirements.
- Apply Career Job Reservation (CJR) limitations on reenlistments from other specialties to specialties that have low values of experience or that have average values of experience and low or moderate training requirements.

Applying the above conclusions requires knowing the values of experience and the training requirements in particular specialties. The following conclusions obtain across the board.

Regardless of the value of experience or the training requirements in a particular specialty, if an increase in the senior force relative to the junior force is desired:

- Use prior service accessions without retraining and retraining into a specialty from other specialties before using prior service accessions with retraining.
- Use prior service accessions with retraining before offering zone A reenlistment bonuses.
- Offer zone A reenlistment bonuses before offering zone B reenlistment bonuses.

Regardless of the value of experience or the training requirements in a particular specialty, if a decrease in the senior force relative to the junior force is desired:

- Use CJR on reenlistments into a specialty from other specialties before using them on reenlistments within the same specialty, and before retraining personnel out at YOS 4.

The above conclusions flow from using ALEC to compare the marginal costs of an action (or combination of actions). Such marginal analysis is the main purpose of ALEC, and its cost and effectiveness measures have been constructed and evaluated with that purpose in mind.

However, ALEC is not limited to marginal analysis. It can also be used to estimate the total cost and total effectiveness generated by a planned set of actions. Of course, this alternative use of ALEC requires stronger assumptions than marginal analysis. In particular, the method of weighting experience must be judged acceptable on average instead of only at the margin.

Nevertheless, the capability of looking at total cost and total effectiveness is useful even if the results must be interpreted cautiously. Analyzing marginal cost effectiveness enables one to discriminate among alternative ways to achieve an objective (such as increasing or decreasing the senior force). Ultimately, however, one must still check (at least approximately) whether the planned set of actions do, in fact, achieve the objective.

ACKNOWLEDGMENTS

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CONTENTS

FIGURES

TABLES

I. INTRODUCTION

The Aggregate Lifecycle Effectiveness and Cost (ALEC) model compares the cost effectiveness of management actions used to control the size and composition of the Air Force enlisted force. That force consists of almost half a million persons working in hundreds of job specialties. Enlisted force managers control this force by actions that alter a specific specialty's gains and losses.

This volume presents the theory and behavioral relationships used by the model and the results of some analyses done with the model. A companion volume, *ALEC (Documentation and User's Guide)*, N-2629/2-AF, describes how the model works and gives operating instructions.

LIFECYCLE AND PART-OF-FORCE PERSPECTIVES

"Management actions" in this analysis are defined in sufficient detail so that (at least approximately) they affect specific cohorts and specific specialties within a cohort. A "cohort" consists of all persons who enter the enlisted force in the same fiscal year, followed throughout their entire career in the Air Force. A "specialty" is a particular job (or group of related jobs) in the enlisted force.

Management actions typically affect the entire future of a cohort. This analysis measures the cost effectiveness of an action by tracing the changes in costs and effectiveness throughout the cohort's lifecycle.

Two or more management actions for the same cohort and specialty constitute a "management plan" for that cohort and specialty. Combining management plans for all cohorts in all specialties constitutes a management plan for the entire enlisted force.

An example of a cohort- and specialty-specific management action is a reenlistment bonus offered to a given specialty in a given fiscal year to persons who, in that fiscal year, reach the end of their first term with four years of service. Reenlistment bonuses are typically offered to a specialty during a range of fiscal years, and for a range of years of service, and consequently they affect several cohorts simultaneously.

However, such an action can be thought of as a collection of closely related cohort-specific actions.

Persons can change specialties during their careers. In that case, the analysis follows the specialty considering reenlistments out of the specialty as losses from the specialty-specific cohort and reenlistments into the specialty as gains to the specialty-specific cohort.

MEASURING EFFECTIVENESS

The cost part of cost effectiveness analysis is straightforward: Just keep track of all the money spent to hire, train, support, and pay the enlisted persons in a cohort. The effectiveness part, however, presents well recognized difficulties.

Many studies have analyzed the relative effectiveness of persons at different stages of an Air Force career. Some examples are: Albrecht (1979); Carpenter-Huffman (1979); Gay (1974); Gay and Albrecht (1979); Gotz and Roll (1979); Haggstrom, Chow, and Gay (1984); and Jacquette and Nelson (1974).

These studies agree that enlisted force productivity tends to increase with experience. However, they do not agree on a specific value of experience.

Getting agreement on a specific estimate of how productivity increases with experience will always be difficult. The value of experienced personnel relative to inexperienced personnel varies among specialties, and specialties change their characteristics over time. Moreover, the marginal value is not necessarily equal to the average value, and the marginal value will vary with the current relative supply of experienced to inexperienced personnel.

This analysis does not solve the effectiveness measurement problem. Rather, it uses a range of values to show which conclusions depend on resolving the question. The hope is that when one action is shown to be more cost effective than another provided that experience is valued at a certain level, it will be easier to get agreement that experience has at least that minimum value than it is to get agreement on the exact value of experience.

The basis for all the measures of effectiveness used in the analysis is the "trained-person-year"--a year of work done by a person in the enlisted force who has completed basic military training, technical school if a specialty requires it, and the part of on-the-job-training (OJT) that is spent learning rather than working.

Alternative measures of effectiveness are constructed from this basic measure in two ways. First, persons in OJT are counted as working only a fraction of the time (the rest of the time they are presumed to be learning rather than doing). The fraction spent not working can be varied to produce alternative effectiveness measures. This analysis uses the estimate that 0.4 of OJT is spent not working (Fleming et al., 1987). Appendix C explores the sensitivity of conclusions to this estimate.

Second, trained-person-years are weighted more as the number of years of service increases. The alternative weighting schemes range from weights that do not increase at all with years of service to weights that go up twice as fast as pay increases with years of service.

The middle of this range--weights that go up in proportion to pay increases with years of service--has a claim to being correct on average. That claim is based on the presumption that the pay scale has been established to recognize average productivity increases with experience.

However, even if this middle-of-the-road weighting system is correct on average, it cannot be correct for all specialties. Pay scales are the same for all specialties, but the productivity increase due to experience varies by specialty. That is why all results in this analysis are reported for a range of weighting systems.

WHY BOTH COST AND EFFECTIVENESS MUST BE DISCOUNTED

This analysis measures the cost effectiveness of an action by the ratio of the discounted stream of costs to the discounted stream of trained-person-years (weighted by alternative weighting schemes) generated by that action.

For example, the extra reenlistments caused by a reenlistment bonus increase costs by the bonus payments in the current year and by the pay and retirement benefits that the additional reenlistees receive in future years, and increase effectiveness by the additional persons working in the current and future years. The cost effectiveness of the reenlistment bonuses action is the ratio of those additional costs (discounted to a present value) to the additional weighted trained-person-years (also discounted to a present value).

Discounting costs to a present value is a familiar technique that requires no justification. Everyone understands that money can be invested to earn interest. For example, at a 4 percent real interest rate, $19,200 this year will grow into $20,000 (in constant dollars) next year. However, there is not a similar automatic realization that effectiveness must also be discounted to a present value when constructing a cost effectiveness ratio.

Nevertheless, a simple example can make the necessity of discounting effectiveness clear. Suppose there are two plans:

- Plan A costs $20,000 this year and delivers one person-year of work this year.
- Plan B costs the same $20,000 this year, but does not deliver the person-year of work until next year.

If effectiveness is not discounted, the two plans are the same. However, by taking $19,200 this year and investing it so that it grows into $20,000 next year, we would get enough money to implement Plan A next year. Plan A has been transformed into one that costs $19,200 this year and delivers one person-year of work next year. Clearly, Plan A is superior to Plan B.

This example shows that we must discount effectiveness to correctly evaluate the cost effectiveness of alternative plans. It also shows that the discount rate used for effectiveness must be the same as the one used for costs.

Keeler and Cretin (1982) present an extensive mathematical discussion of the point made by this example.

CHOICE OF DISCOUNT RATE

"The discount rate is conventionally applied to constant-value (i.e., inflation-adjusted) dollars. With moderate inflation, the discount rate is approximately the interest rate less the expected rate of inflation." (Keeler and Cretin, 1982, p. 4.)

This definition is clear enough, but applying it is never straightforward. Implementation problems arise because interest rates contain risk premiums (a junk bond has a higher interest rate than a federally backed mortgage), and the future rate of inflation is never known exactly. When one turns to historical analysis, both interest rates and inflation rates vary from year to year, so the estimate of the discount rate depends upon the time period used in the analysis.

The underlying problem, of course, is that the discount rate itself actually varies slightly from year to year in an unpredictable fashion. As in any modeling effort that approximates a variable by an average, estimates differ.

Estimates of the real annual discount rate are usually between 3 and 5 percent. This analysis uses 4 percent. Appendix C shows that conclusions about the cost effectiveness of enlisted force management actions are not very sensitive to the discount rate for small variations about 4 percent. (Users of the microcomputer model behind this analysis can set the discount rate to any value they choose.)

The major pitfalls to avoid are not discounting at all (implicitly using a zero discount rate), or using an excessively high real discount rate. The major virtue to embrace is consistency. The same discount rate should be used throughout an entire analysis. Otherwise, small differences in the cost effectiveness of different actions may be caused solely by the different choice of discount rate.

In this analysis, the "discount rate" refers to the percentage increase in the constant value of money during a year. If the discount rate is 4 percent, 100 dollars this year grows into $100(1.04) = 104$ dollars next year. The "discount factor" refers to the multiplier that

converts next year's money into this year's money. If the discount rate is 4 percent, 104 dollars next year is worth $104/(1.04) = 100$ dollars this year. The discount factor is $1/(1.04)$. Throughout the analysis, "d" indicates the discount rate, and "D" indicates the discount factor.

OVERVIEW

Section II explains the decision to use the lifecycle perspective in analyzing the cost effectiveness of enlisted force management. The lifecycle perspective is advantageous because management actions tend to influence specific cohorts rather than specific fiscal years.

Section III reviews the management actions used to control the size and composition of the enlisted force. The actions are classified into those that increase the force and those that decrease the force.

Then, Sec. IV presents the theory and empirical findings that explain how management actions affect enlisted force behavior. This section draws on work done by the EFMP to support all the decision support models being built by the project, not just the ALEC model.

Next, Secs. V and VI analyze the effectiveness measures and the costs used in constructing cost effectiveness ratios.

Finally, Secs. VII and VIII present findings on the cost effectiveness of the management actions listed in Sec. III. Results are given for a range of experience values for the average specialties in the low, moderate, and high training sectors of the enlisted force. (See App. A for the list of specialties in each sector.)

II. LIFECYCLE VIEW OF COST-EFFECTIVENESS ANALYSIS

Concentrating on cohort lifecycles may seem at first to be a very partial approach to analyzing the cost effectiveness of enlisted force management. The usual approach to this question examines fiscal year costs and force strengths across all cohorts and models the effect of a plan one fiscal year at a time.

However, cohort-specific management actions turn out to be the fundamental building blocks of an overall management plan. Knowledge of the cost effectiveness of those fundamental building blocks is invaluable in the construction of alternative plans.

This section first looks at the cost effectiveness problem as a whole and then compares the annual and lifecycle approaches to that problem. The lifecycle approach has much to recommend it.

COST EFFECTIVENESS ANALYSIS AT THE MARGIN

The overall cost effectiveness of the enlisted force in a reference situation is, of course, the ratio of cost to effectiveness:

$$R = C/E \tag{2.1}$$

where R = cost effectiveness in reference situation,
C = cost in reference situation,
E = effectiveness in reference situation.

Under a planned deviation from that reference situation the cost effectiveness would become:

$$R(i) = [C + c(i)]/[E + e(i)] \tag{2.2}$$

where $R(i)$ = cost effectiveness when the reference situation
is modified by plan i,
$c(i)$ = additional cost caused by plan i,
$e(i)$ = additional effectiveness caused by plan i.

Now, measuring changes in cost, $c(i)$, and effectiveness, $e(i)$, caused by a plan is difficult enough. Measuring the reference case cost, C, and effectiveness, E, is much more difficult. This being so, we would like to be able to judge the value of a plan simply by looking at its marginal cost effectiveness:

$$r(i) = c(i)/e(i) \qquad\qquad (2.3)$$

where $r(i)$ = marginal cost effectiveness of the plan.

Unfortunately, marginal cost effectiveness does not necessarily imply better overall cost effectiveness. In symbols, $r(i) < r(j)$ does not necessarily imply that $R(i) < R(j)$.

For example, suppose one plan increases cost by 5 percent and effectiveness by 10 percent, while another plan increases cost by 75 percent and effectiveness by 100 percent. The first plan has better marginal cost effectiveness but worse overall cost effectiveness.

The assumptions are: $c(i) = 0.05C$, $e(i) = 0.10E$, $c(j) = 0.75C$, $e(j) = 1.00E$. The first plan has better marginal cost effectiveness because $0.5C/E$ and $r(j) = 0.75C/E$. The second plan has better overall cost effectiveness, because $R(i) = 0.95C/E$ and $R(j) = 0.88C/E$.

The problem is that we have compared plans of vastly different scales. The plan with large effects does better overall, not because it is more efficient but because it does more. An analogy may be helpful here. If you have \$100 to invest, an investment that doubles your money but will only allow you to invest \$1 is not as useful as an investment that pays only 10 percent interest but will accept the entire \$100.

If we restrict comparisons to plans with similar scales, then marginal cost effectiveness becomes a good measure of a plan's worth. In the limit, we get the two classic cases of cost effectiveness analysis: In one, case scale is defined by effectiveness ("minimize change in cost holding change in effectiveness constant") and in the other case scale is defined by cost ("maximize change in effectiveness holding change in cost constant"). Equations (2.2) and (2.3) show that

if two plans have the same effectiveness, $e(i) = e(j)$, or if they have the same cost, $c(i) = c(j)$, then $r(i) < r(j)$ implies $R(i) < R(j)$.

Keeping in mind the need to compare plans of similar scales, this analysis can therefore restrict itself to examining marginal cost effectiveness. The rest of the analysis drops the "marginal" adjective and simply refer to the "cost effectiveness of a plan" by which we mean the ratio of the changes in cost caused by the plan to the changes in effectiveness caused by the plan.

ANNUAL VS. LIFECYCLE PERSPECTIVES

The cost effectiveness of a plan, $r(i) = c(i)/e(i)$, can be analyzed from either an annual perspective or a lifecycle perspective. Both perspectives are derived from a common understanding of a plan's effect on cost and effectiveness.

A general formula for the cost change caused by a plan is:

$$c(i) = \sum_y \sum_h c(y,h,i)\, D(y) \qquad (2.4)$$

where $c(i)$ = present value of cost change caused by plan i,
$c(y,h,i)$ = cost change in fiscal year y to cohort h caused by plan i,
$D(y)$ = discount factor.

Similarly, a general formula for the effectiveness change caused by a plan is:

$$e(i) = \sum_y \sum_h e(y,h,i)\, D(y) \qquad (2.5)$$

where $e(i)$ = present value of cost change caused by plan i,
$e(y,h,i)$ = effectiveness change in fiscal year y to cohort h caused by plan i,
$D(y)$ = discount factor.

Annual Perspective

Equation (2.6) presents the annual perspective on cost effectiveness analysis. It views cost and effectiveness changes fiscal year by fiscal year and then combines fiscal years into an overall evaluation of a plan.

Equation (2.6) derived from Eqs. (2.4) and (2.5) by first summing over all cohorts and then expressing the cost effectiveness of a plan as a weighted average of fiscal-year-specific cost effectiveness ratios:

$$r(i) = \sum_y W(y,i) \ r(y,i) \qquad (2.6)$$

where $r(i) = c(i)/e(i) = $ cost effectiveness of plan i,

$r(y,i) = c(y,i)/e(y,i) = $ fiscal-year cost effectiveness,

$c(y,i) = \sum_h c(y,h,i) = $ cost change over all cohorts,

$e(y,i) = \sum_h e(y,h,i) = $ effectiveness change over all cohorts,

$W(y,i) = e(y,i)D(y)/\sum_y e(y,i)D(y) = $ fiscal-year weight.

Lifecycle Perspective

Equation (2.7) presents the lifecycle perspective on cost effectiveness analysis. It views cost and effectiveness changes cohort by cohort, and then combines cohorts into an overall evaluation of a plan. It is derived from Eqs. (2.4) and (2.5) by first summing over all fiscal years and then expressing the cost effectiveness of a plan as a weighted average of cohort-specific cost effectiveness ratios:

$$r(i) = \sum_h W(h,i) \ r(h,i) \qquad (2.7)$$

where $r(i) = c(i)/e(i)$ = cost effectiveness of plan i,

$r(h,i) = c(h,i)/e(h,i)$ = cohort cost effectiveness,

$c(h,i) = \sum_y c(y,h,i)D(y)$ = cost change over all fiscal years,

$e(h,i) = \sum_y e(y,h,i)D(y)$ = effectiveness change over all fiscal years,

$W(h,i) = e(h,i)/\sum_h e(h,i)$ = cohort weight.

ADVANTAGE OF THE LIFECYCLE PERSPECTIVE

Both the annual and lifecycle perspectives are analytically correct. In fact, as Eqs. (2.6) and (2.7) show, the two perspectives are mirror images of each other. So the choice between them lies not in their algebra, but rather in their practicality.

The annual perspective is easier to implement if plans tend to influence many cohorts for a few fiscal years. The lifecycle perspective is easier to implement if plans tend to influence many fiscal years but few cohorts.

This distinction does not at first seem to offer much help because plans for the enlisted force typically affect many cohorts over many fiscal years. However, when we look at the actions of which plans are constructed, the virtues of the lifecycle perspective become clear.

The management actions that are used to control the enlisted force either are customarily defined to affect only a single cohort, or can easily be made cohort-specific. For example, as mentioned in Sec. I, reenlistment bonuses are customarily offered to several cohorts at a time, but they can be thought of as a collection of separate offers to each of the several cohorts.

Moreover, these management actions typically affect all the remaining years in the cohort's lifecycle. This presents no problem for the lifecycle perspective because the technique always considers the entire lifecycle, whether the effects of an action extend that far or not. However, an annual modeling effort would have to consider up to 30 fiscal years to capture all the effects of some cohort-specific actions (because an Air Force career can last 30 years).

In fact, early release of persons who have decided not to reenlist is the only action used by enlisted force managers whose effects are confined to a small number of fiscal years. This action typically moves losses from the next fiscal year to the current fiscal year. Both personnel costs and trained-person-years decrease in the two fiscal years involved, and only those years are affected.

Another way to realize the advantage of the lifecycle perspective over the annual perspective is to consider the information content of individual cohort cost effectiveness ratios relative to that of individual fiscal year cost effectiveness ratios. Because management actions tend to be cohort-specific, a single cohort's cost effectiveness ratio presents an adequate evaluation of an action.

In contrast, because management actions typically affect more than one fiscal year, a single fiscal year's cost effectiveness ratio can be misleading or even meaningless. For an extreme example, consider accessions into specialty that has a technical school that lasts more than a year. For the first fiscal year following the accession, cost will be positive because persons in training receive pay and instruction; however, effectiveness will be zero, because no one will be out of technical school yet. Consequently, the cost effectiveness ratio for that first fiscal year will be infinitely large.

III. MANAGEMENT ACTIONS

Enlisted force managers influence force behavior by controlling:

- Accessions,
- Retraining flows into and out of a specialty,
- Selected reenlistment bonuses,
- Early releases, and
- Career Job Reservations for entry to the second term.

To define specific management actions, these general types of actions must be subdivided by the time during the life cycle at which the action occurs. With that subdivision, there are a total of 17 actions to analyze (see Table 3.1). All these actions are feasible, and used, under current Air Force regulations.

This section discusses the 17 management actions under two headings: (a) actions that increase the force, and (b) actions that decrease the force. The actions, including those under the different headings, can be used in combination to achieve desired force behavior.

The ALEC model, as currently implemented, does not contain management actions that alter the basic structure of enlisted force management. For example, terms of enlistment cannot be changed from the currently offered four or six year periods; the existence of the CAREERS Program, which allows changes in specialty at the end of the first term, is a given;[1] the years-of-service ranges in which reenlistment bonuses are offered cannot be altered; and the years-of-service at which retirement benefits become available cannot be changed from the current 20 years.

The ALEC model has these structural policies built into its accounting systems and behavioral equations. Analyzing the structural policies would require revising the model's fundamental architecture.

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[1]The flows in the CAREERS Program are, however, affected by reenlistments bonuses and by Career Job Reservations (CJRs) and those factors are explicit management actions in this analysis.

Table 3.1

MANAGEMENT ACTIONS

Management Action	Measurement Unit
Actions that Increase the Force	
Accessions:	
Non Prior Service, 4-Year TOE[a]	Persons per year
Non Prior Service, 6-Year TOE	Persons per year
Prior Service, no retraining	Persons per year
Prior Service, with retraining	Persons per year
Retraining into a Specialty:	
At 4 years of service	Persons per year
At 8 years of service	Persons per year
At 12 years of service	Persons per year
Selective Reenlistment Bonuses:	
Zone A	Bonus multiple
Zone B	Bonus multiple
Zone C	Bonus multiple
Actions that Decrease the Force	
Early Release:	
First Term	Persons per year
Second Term	Persons per year
Retraining out of a Specialty:	
At 4 years of service	Persons per year
At 8 years of service	Persons per year
At 12 years of service	Persons per year
Career Job Reservations	
For a Specialty's Own Reenlistments	Persons per year
For Reenlistments from Other Specialties	Persons per year

[a]TOE = term of enlistment.

The difficulty of such revision would depend on the specifics of the structural changes to be analyzed.

Note that ALEC also is not set up to evaluate actions that the Air Force does not control such as educational benefits, pay scales, and retirement benefits; although the effect of current levels of these actions is comprehended by ALEC's behavioral equations. Nor is ALEC set up to analyze actions that are not currently used to guide enlisted force to any significant extent, such as accession bonuses or separation payments. Moreover, ALEC cannot analyze promotion policy. Omitting the grade dimension is the price that was paid to obtain a model that would run rapidly on a microcomputer.

Adding management actions to ALEC is possible in principle. Doing so would require defining the actions operationally, using ALEC's accounting systems and obtaining estimates of the effect of the actions on enlisted force loss and reenlistment behavior.

ACTIONS THAT INCREASE THE FORCE
Accessions

Non Prior Service accessions are new hires just starting their Air Force career. NPS accessions are for a first term of either four or six years. Typically, about 85 percent of NPS accessions are for a four-year first term. However, the proportion varies by specialty. When operating the ALEC model, the user selects four-year and six-year NPS accessions separately, so the proportion four-year enlistees is whatever the user chooses.

Prior Service (PS) accessions are people who have had previous military experience (usually a first term in the Air Force) who are reenlisting after some time in the civilian economy. If the time away from the military has been short enough, and if the person is rejoining the previous specialty, no retraining is required. If enough time has passed for skills to be out of date, however, or if the reenlistment is into a new specialty, then the new term of enlistment must begin with technical school and OJT.

In the ALEC model, PS accessions are assumed to be into the second term, with four years of prior military experience. PS accessions do

not receive reenlistment bonuses, even when one is offered in the specialty.

Retraining into a Specialty

Persons who leave one specialty and join another must go through technical training and OJT in the new specialty. Such retraining flows can occur at any stage of the lifecycle; however, the ALEC model considers only three possibilities: retraining at four, eight, or 12 years of service.

The retrainees are assumed to enter the new specialty at the start of a new term of service (the second, third, or fourth term). The retrainees receive a reenlistment bonus if one is offered in the new specialty, and their choice of term of service depends upon the bonus offered.

Note that ALEC interprets this action to be in addition to any retraining flows caused by the Careers Program (see Sec. IV). This is an appropriate specification because the flows in the Careers Program happen automatically. It is the deviations from those flows that are caused by management action.

Selective Reenlistment Bonuses

If a reenlistment bonus is offered in a specialty, persons who reenlist receive a bonus payment equal to a "bonus multiple" (a number between 0 and 6), times monthly basic pay, times the number of years in the new term of enlistment.

The reenlistee receives 75 percent of the bonus as a lump sum upon reenlistment and the remaining 25 percent of the bonus in equal payments during the years of the new term. The fraction of the bonus that is a lump sum payment is an explicit input parameter of the ALEC model. So, if the current 75 percent policy changes, users of the model can easily change to the new policy.

"Zone A" bonuses are offered to reenlistments that occur at years of service (YOS) 2, 3, 4, or 5.[2] Usually this is a reenlistment from the first to second category of enlistment.

"Zone B" bonuses are offered to reenlistments that occur at YOS 6, 7, 8, or 9. Usually this is a reenlistment from the second category to a career category of enlistment.

"Zone C" bonuses are offered to reenlistments that occur at YOS 10, 11, 12, or 13. Usually this is a reenlistment from one career category of enlistment to another.

Reenlistment bonuses decrease loss rates and increase reenlistment rates in a specialty (see Sec. III). This is the point of reenlistment bonuses; in return for paying the bonus the Air Force receives additional reenlistments that increase the size of the senior force.

Zone A reenlistment bonuses have a more complex effect than zone B and C bonuses. They increase reenlistment rates at the point in the lifecycle where the bonus is offered. However, unlike zone B and C bonuses, zone A bonuses decrease reenlistment rates later in the lifecycle (see Sec. III). This happens because not all the people who sign up for a second term to get the zone A bonus intend to make the Air Force their career, and their departure at the end of the second term decreases reenlistment rates at that point. The net effect of zone A bonuses on the number of reenlistments is positive everywhere, however, because the increased rate at the start of the second term outweighs the decreased rate at the end of it.

Zone A reenlistment bonuses also powerfully affect the cross-specialty flows in the CAREERS Program. That program offers enlisted personnel the chance to change specialties at the start of their second term. Because of that program, some of a specialty's reenlistments from the first term may go to other specialties, and some of a specialty's

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[2]Note that "years of service" is defined like "years old" and therefore is 0 during the first year that a person is in the Air Force, 1 during the second year, and so on. Thus, a person who reenlists before the end of his sixth year in the Air Force will receive a zone A bonus if one is offered in the relevant specialty.

reenlistments into the second term may come from other specialties. When a bonus is offered in a specialty, the reenlistments-out generally decrease and the reenlistments-in generally increase (see Sec. III).

Finally, all reenlistment bonuses affect terms of enlistment. Because the bonus payment increases with term of enlistment (TOE), reenlistees tend to choose six-year (rather than four-year) terms of enlistment when a reenlistment bonus is offered (see Sec. III). This TOE effect of bonuses is an important additional benefit to the Air Force. Note that the extra years of service are obtained not only from the additional reenlistments caused by the bonus, but also from the reenlistments that would have occurred even if the bonus had not been offered.

ACTIONS THAT DECREASE THE FORCE

Early Release

Persons nearing the end of term of enlistment who are not planning to reenlist may be offered the chance to leave the Air Force before the end of that term of enlistment. This action is usually taken to bring the overall force level down to the "end strength" mandated by Congress for the end of a given fiscal year.

This analysis assumes that any early releases occur one year before the end of the term of enlistment. This specification is made because the ALEC model uses one year intervals in its accounting systems. The assumption is not critical, however, because the cost effectiveness of 100 persons leaving one year early is approximately the same as 200 persons leaving one-half year early, or 400 persons leaving one-fourth year early. In all these cases, 100 person-years of effectiveness are lost, and the pay and support services for 100 person-years are saved.

Retraining Out of a Specialty

This action is the same as "retraining into a specialty," discussed above, except now the action is looked at from the origin specialty rather than from the destination specialty.

Note again that ALEC interprets this action to be in addition to any retraining flows caused by the Careers Program (see Sec. IV). This

is an appropriate specification because the flows in the Careers Program happen automatically. It is the deviations from those flows that are caused by management action.

Career Job Reservations

The CAREERS Program that allows persons to choose new specialties at the start of the second term has the capability of limiting entry into specialties that are overmanned. This limitation is accomplished by ceilings (Career Job Reservations) on the number of reenlistments into the second term. One ceiling limits the number of reenlistments into a specialty from the same specialty. A second limits the number of reenlistments into a specialty from other specialties.

IV. COHORT BEHAVIOR

The cost effectiveness of the management actions listed in Sec. III depends on how those actions affect enlisted force behavior. The ALEC model traces the behavior of an enlisted force cohort from its start as NPS accessions until its end as losses and retirements. This section discusses the theory and empirical parameters behind that modeling. Vol. 2 presents the accounting system and computational steps that ALEC uses to implement this theory.

The most basic building block in the ALEC model is the category of enlistment. The model follows a cohort during its first term of enlistment, counting losses and reenlistments. Then it follows the reenlistments during their second term. Third and subsequent terms of enlistment are analyzed together up to the point at which retirement benefits become available at 20 years of service. Finally, the model follows what remains of the cohort though the retirement-eligible years.

"Attrition losses" (involuntary departures for death, disability, or disciplinary reasons) occur every year of the cohort's life cycle. "Retirement losses" (the decision to leave the Air Force and start receiving retirement benefits) occur every year after 20 years of service. ALEC models these losses by constant loss rates that are assumed not to be affected by the management actions considered by the model. (The loss rates used in ALEC are reported by specialty in Vol. 2, App. A.)

In each of the first, second, and career categories of enlistment, enlisted personnel face three decision points. The first is when their term of enlistment ends. If they extend their term of enlistment at that first decision point, then they face additional decision points at the ends of the first and second extension years.

At each decision point, enlisted persons must choose one of three actions:

- Leave,
- Extend for an additional year in the same category of enlistment (possible at end of term of service (ETS) and the end of the first extension year), or
- Reenlist into a new category of enlistment.

Those who reenlist have two additional choices to make:

- Specialty to reenlist into (enlisted persons have a choice if it is their first reenlistment) and
- Term of enlistment (a choice of either four or six years is available at all reenlistments).

This section shows how the management actions presented in Sec. III (in particular selective reenlistment bonuses, the military wage level, and CJRs) affect those choices. It also shows how the civilian unemployment rate affects the choices. The unemployment rate is, of course, not an Air Force management action, but it is an important characteristic of the economic environment influencing the cost effectiveness of enlisted force management actions.[1]

This section does not discuss the effects of accession or retraining flows (other than those caused by the CAREERS Program). Modeling those flows is simply a matter of adding them to or subtracting them from the cohort at the appropriate point in its life cycle.

LOSS AND EXTENSION RATES

The EFMP has modeled the decision to leave and the decision to extend at each decision point. The "loss rate" is the probability that an enlisted person who reaches a decision point will leave at that decision point. The "extension rate" is the probability that an

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[1] Users of ALEC must choose an assumed long-run average civilian unemployment rate when operating the model. That choice is made implicitly by a default assumption during ordinary operation of the model. However, the documentation explains how the default condition can easily be changed.

enlisted person who reaches a decision point, but does not leave, will extend.

It was not necessary to model the decision to reenlist explicitly, since if we know the first two decisions we know the third (at a decision point, reenlistments equal inventory less losses less extensions).

The econometric analyses behind the loss and extension models are reported in Carter et al. (1987). This subsection presents the results from that report that are required for the cost effectiveness analyses of management actions. Those results show how loss and extension rates at each decision point are affected by reenlistment bonuses, the civilian unemployment rate, and the military wage level.

Table 4.1

VARIABLES AFFECTING DECISIONS

Variable	Transformed Variable	Description of Transformed Variable
Reference probability, K	K	Constant
Percent civilian unemployment, U	$\ln(U) - \ln(U_o)$	Log % civilian unemployment
Military/civilian wage ratio, W	$\ln(W) - \ln(W_o)$	Log military/civilan wage ratio
Bonus multiple, M	If $M < 1$ then M, else 1	First bonus multiple
	If $M < 1$ then 0, else $M - 1$	Higher bonus multiples
Past zone A bonus	if yes then 1, else 0	Past zone A bonus

NOTE: U_o and W_o are the variable values in the reference situation.

Variables Affecting Decisions

Variables that affect loss and extension decisions include:

- Civilian unemployment (percent),
- Military pay relative to civilian pay,
- Reenlistment bonus multiples.

After appropriate transformations (see Table 4.1), these variables affect loss and extension rates either linearly or piecewise linearly.

The unemployment and wage variables are transformed by taking the logarithm. The bonus variable is transformed by splitting it into two variables: One picks up the marginal effect of bonus multiples less than 1.0, and the other picks up the marginal effects of bonus multiples 1.0 or larger (this is the piecewise linear part of the model). "Past zone A bonus" is a dummy variable equal to 1 if the enlisted personnel making the decision ever received a zone A bonus.

Other variables, such as demographic characteristics, also affect loss and extension rates. Their effects are incorporated into the constant, K. The effects of these other factors are reported in Carter et al. (1987). The reference situation that K reflects is FY80 unemployment and wage conditions, and no reenlistment bonuses.

Econometric Coefficients

Tables 4.2, 4.3, and 4.4 present the coefficients that link the behavior of loss and extension rates to the unemployment, pay, and bonus variables.[2]

With two exceptions, these coefficients are either zero or negative. That means that civilian unemployment, military pay, and reenlistment bonuses tend to decrease both loss and extension rates. This finding is not surprising because decreased civilian employment opportunities and increased military compensation make reenlisting in

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[2] One behavioral coefficient did not fit in the format of these tables. The additional coefficient gives the additive effect on retirement rates of the logarithm of % civilian unemployment. The coefficient is -0.1352 (see Table 9.3 in Carter et al., 1987).

Table 4.2

COEFFICIENTS IN THE LINEAR EQUATIONS FOR FIRST-TERM
LOSS AND EXTENSION RATES

Transformed Variable	End of Term of Service (ETS)	First Extension Year	Second Extension Year
Loss Rate (probability of leaving)			
Constant	1.000	1.000	1.000
Log % civilian unemployment	-0.361[a]	-0.404 × P	-0.404
Log military/civilian wage ratio	-0.437	0.125 × P	0.125
First bonus multiple	-0.034	0.000	0.000
Higher bonus multiples	-0.013	0.000	0.000
Past zone A bonus	0.000	0.000	0.000
Extension Rate (probability of extending, given stay)			
Constant	1.000	1.000	1.000
Log % civilian unemployment	0.000	0.000	0.000
Log military/civilian wage ratio	0.000	0.000	0.000
First bonus multiple	-0.038	0.000	0.000
Higher bonus multiples	-0.038	0.000	0.000
Past zone A bonus	0.000	0.000	0.000

SOURCE: Carter et al. (1987) (Tables 5.2, 8.1, and 8.2).

NOTES: See Table 4.1 for exact variable definitions. P = probability that an extension is for a year or less, given that an extension has occurred (see App. B).

[a]This coefficient is for a four-year first term. It equals 0.000 for a 6-year first term.

the military more attractive. (Recall that persons at the end of their term of enlistment must either leave, extend, or reenlist. If the first two decrease, then the third must increase.)

The first exception is the positive effect of military wages on first-term losses from extensions (see Table 4.2). Note, however, that this effect is small relative to the negative effect of military wages on losses at the first-term original end of term of service. Therefore, the overall effect of military wages on first-term losses is negative, as expected.

The second exception is the positive effect of a past zone A bonus on second-term losses (see Table 4.3). This effect occurs because persons who reenlisted at the end of their first term to get a bonus do not have the same propensity to make the Air Force a career as persons who would have reenlisted even if there were no bonus. Consequently, at the end of the second term, the proportion of people who reenlist for a third term is smaller with a zone A bonus than without.

However, this smaller reenlistment rate gets applied to a larger base (the reenlistments that would have occurred without the zone A bonus plus the reenlistments that occurred because of it. This larger base outweighs the smaller reenlistment rate, so the total number of

Table 4.3

COEFFICIENTS IN THE LINEAR EQUATIONS FOR SECOND-TERM
LOSS AND EXTENSION RATES

Transformed Variable	End of Term of Service (ETS)	First Extension Year	Second Extension Year
Loss Rate (probability of leaving)			
Constant	1.000	1.000	1.000
Log % civilian unemployment	-0.234	-0.349 × P	-0.349
Log military/civilian wage ratio	-0.128	-0.957 × P	-0.957
First bonus multiple	-0.042	0.000	0.000
Higher bonus multiples	-0.042	0.000	0.000
Past zone A bonus	0.037	0.000	0.000
Extension Rate (probability of extending, given stay)			
Constant	1.000	1.000	1.000
Log % civilian unemployment	-0.376	0.000	0.000
Log military/civilian wage ratio	-0.633	0.000	0.000
First bonus multiple	-0.142	0.000	0.000
Higher bonus multiples	-0.142	0.000	0.000
Past zone A bonus	0.000	0.000	0.000

SOURCE: Carter et al. (1986) (Tables 6.1, 6.2, and 8.2).
NOTE: See Table 4.1 for exact variable definitions. P = probability that an extension is for a year or less, given that an extension has occurred (see App. B).

reenlistments into the third term is larger with a zone A bonus than without.

CAREERS PROGRAM FLOWS

Enlisted personnel who reenlist at the end of the first term do not necessarily choose to stay in their first-term specialty. Some of them retrain into new specialties at the start of their second term. The program that makes this retraining possible is called the CAREERS Program.

Table 4.4

COEFFICIENTS IN THE LINEAR EQUATIONS FOR CAREER-TERM
LOSS AND EXTENSION RATES

Transformed Variable	End of Term of Service (ETS)	First Extension Year	Second Extension Year
Loss Rate (probability of leaving)			
Constant	1.000	1.000	1.000
Log % civilian unemployment	-12.518 × F	-0.102 × P	-0.102
Log military/civilian wage ratio	-40.088 × F	-0.134 × P	-0.134
First bonus multiple	-2.167 × F	-0.007 × P	-0.007
Higher bonus multiples	-2.167 × F	-0.007 × P	-0.007
Past zone A bonus	0.000	0.000	0.000
Extension Rate (probability extending, given stay)			
Constant	1.000	1.000	1.000
Log % civilian unemployment	0.000	0.000	0.000
Log military/civilian wage ratio	0.000	0.000	0.000
First bonus multiple	0.000	0.000	0.000
Higher bonus multiples	0.000	0.000	0.000
Past zone A bonus	0.000	0.000	0.000

SOURCE: Carter et al. (1987) (Tables 7.1, 7.5, and 8.2).
NOTES: See Table 4.1 for exact variable definitions. P = probability that an extension is for a year or less, given that an extension has occurred; $F = \exp(-(YOS)/2) - \exp(-10)$; see App. B.

This program divides the first-term reenlistment flow into three flows: (a) reenlistments into the same specialty, (b) reenlistments out of the specialty into other specialties, and (c) reenlistments who change their minds about reenlisting and leave the Air Force. The third flow occurs in specialties where CJRs are placed on reenlistments into the second term, and some of the rejected reenlistments leave the Air Force rather than choosing an alternative specialty.

The following discussion of the CAREERS Program first shows how the program behaves if there are no CJRs, then adds the effect of CJRs, and finally adapts the theory to lifecycle analysis. The discussion concludes with estimates of the program's behavioral parameters.

Theory of CAREERS Program Flows, Without Career Job Reservations

The number of reenlistments that stay in the same specialty is proportional to the total number of reenlistments from that specialty. The fraction who stay increases with the reenlistment bonus offered by the specialty. However, that fraction cannot, of course, become greater than 1.0.

$$RS = \min\{R[K1 + (K2)B], R\} \tag{4.1}$$

where R = Total reenlistments at the end of a specialty's
         first term,
      RS = Reenlistments staying in the same specialty
         at the start of the second term,
      K1 = Fraction of total reenlistments that chooses to
         stay in the same specialty when there is no
         reenlistment bonus,
      K2 = Additional fraction choosing to stay in the same
         specialty per bonus multiple,
       B = Reenlistment bonus multiple.

The number of reenlistments who choose to retrain into another specialty equals total reenlistments less those who choose to stay.

$$RO = R - RS \qquad\qquad (4.2)$$

where RO = Reenlistments out of a specialty at the start of
the second term.

The number of reenlistments into a specialty depends upon the number of reenlistments out of all other specialties and the proportion of such reenlistments that choose the specialty being analyzed. A global examination of origins and destinations is impossible in this analysis because the power of this analysis comes from focusing on one part of the force at a time. Instead, this analysis treats the inflow when there is no reenlistment as a constant (for a given specialty). This assumption is acceptable as long as management actions remain close to their historical levels.

The constant inflow is then modified by a factor that shows how a specialty's reenlistment bonus increases reenlistments from other specialties.

$$RI = (K3)\exp((K4)B) \qquad\qquad (4.3)$$

where RI = Reenlistments into a specialty from other specialties
at the start of the second term;
K3 = Reenlistments into a specialty from other specialties
at the start of the second term, when there is no
reenlistment bonus;
K4 = Fraction increase in reenlistments from other
specialties per bonus multiple (this approximate
interpretation of the coefficient in the exponential
factor is strictly correct only for very small
bonus multiples).

Adding Career Job Reservations to the Theory

When specialties are overmanned, one of the ways that their size can be reduced is to limit entry into the second term. The limiting is done by imposing ceilings (CJRs) on the numbers of reenlistments into the specialty's second term.

Accounting for the effect of the reenlistment ceilings makes the theory presented in Eqs. (4.1) through (4.3) considerably more complex. First of all, the reenlistment flows in Eqs. (4.1) through (4.3) become potential flows that will be modified by the CJRs before becoming actual flows.

$$PRS = min\{(PR)[K1 + (K2)B], PR\} \qquad (4.4)$$

$$PRO = PR - PRS \qquad (4.5)$$

$$PRI = (K3)exp((K4)B) \qquad (4.6)$$

where   PR = Potential total reenlistments at the end of a
             specialty's first term,
       PRS = Potential reenlistments staying in the same specialty
             at the start of the second term,
       PRO = Potential reenlistments out of a specialty at the
             start of the second term,
       PRI = Potential reenlistments into a specialty from other
             specialties at the start of the second term.

The actual reenlistment flows staying in the same specialty or retraining into new specialties equal the minimum of the potential flows and the ceilings.

$$RS = min(PRS, CJRS) \qquad (4.7)$$

$$RI = min(PRI, CJRI) \qquad (4.8)$$

where CJRS = Career Job Reservations for reenlistments into
             the same specialty,
      CJRI = Career Job Reservations for reenlistments into
             a specialty from other specialties.

Some of the rejected reenlistments choose to leave the Air Force rather than settle for a second choice specialty. The reenlistments who give up are extra losses.

$$LRS = (K5)(PRS - RS) \qquad (4.9)$$

$$LRI = (K5)(PRI - RI) \tag{4.10}$$

where LRS = Losses from rejected reenlistments into the same
specialty,

LRI = Losses from rejected reenlistments from other
specialties into this specialty,

K5 = Fraction of rejected reenlistments who leave the
Air Force.

The potential reenlistments staying in a specialty who are rejected but nevertheless choose to remain in the Air Force become additional reenlistments out of the specialty.

$$RO = PR - RS + (1 - K5)(PRS - RS) \tag{4.11}$$

Adapting the Theory to Lifecycle Analysis

In the ALEC model, the constant term, K3, of the inflow equation, Eq. (4.6), is modeled as a multiple of NPS accessions.

$$K3 = (K3a)(NPS) \tag{4.12}$$

where NPS = Non Prior Service accessions at the start of a
cohort's lifecycle,

K3a = Reenlistments into a specialty from other specialties
at the start of the second term, when there is no
reenlistment bonus, as a fraction of NPS accessions
at the start of the cohort's lifecycle.

The reason for this specification is so that ALEC can be operated at any scale (where scale is defined by the NPS accessions that start the lifecycle analysis of a cohort). The cost effectiveness ratios that are ALEC's output do not depend upon scale (because the scale in the cost numerator cancels the scale in the effectiveness denominator when making the ratio). This being so it would be a waste of time to have to worry about operating the model at a correct scale just so the CAREERS Program component worked correctly. Instead, the revised specification

makes the CAREERS Program component work correctly no matter what scale is chosen for the lifecycle analysis.

Empirical Constants

To make the model of the CAREERS Program operational we need estimates of the empirical constants K1 through K5.

K1 = Fraction of total reenlistments that chooses to stay in the same specialty when there is no reenlistment bonus;

K2 = Additional fraction choosing to stay in the same specialty per bonus multiple;

K3a = Reenlistments into a specialty from other specialties at the start of the second term, when there is no reenlistment bonus, as a fraction of NPS accessions at the start of the cohort's lifecycle;

K4 = Fraction increase in reenlistments from other specialties per bonus multiple (this approximate interpretation of the coefficient in the exponential factor is strictly correct only for very small bonus multiples);

K5 = Fraction of rejected reenlistments who leave the Air Force.

The following estimates are from Gracè Carter's econometric analyses for the EFMP's Middle Term Disaggregate Inventory Projection Model (IPM).

K1 = depends on specialty (see Vol. 2, App. A)

K2 = 0.0622

K3 = depends on specialty (see Vol. 2, App. A)

K4 = 0.264

K5 = .5

TERMS OF ENLISTMENT

An enlisted person who decides to reenlist then faces the decision whether to reenlist for a four- or six-year term. Not surprisingly, this decision is powerfully affected by the level of selective reenlistment bonuses in the specialty into which the person reenlists.

The reason for this bonus effect is that the amount of the bonus offered is directly proportional to the number of years in the term of enlistment. Therefore, a person who signs up for six years receives a 50 percent larger bonus than a person who signs up for four years.

As Table 4.5 shows, most of the bonus effect on term of enlistment is caused by the first two bonus multiples. Bonus multiples higher than 2.0 have little or no effect on the term of enlistment.

The table reports effects for integer bonus multiples. Effects for fractional bonus multiples are estimated by linear interpolation.

EXAMPLE: HOW ZONE A BONUSES AFFECT THE FORCE

The effect of zone A reenlistment bonuses on the discounted trained-person-years produced by a cohort illustrates all three types of cohort behavior discussed in this section.

Zone A reenlistment bonuses increase the number of first term enlisted persons who reenlist for a second term (by decreasing loss and extension rates).

In addition, zone A bonuses decrease the number of reenlistments who leave a specialty at the end of the first term and increase the number of reenlistments into the second term from other specialties (through CAREERS Program flows).

Finally, zone A bonuses increase the number of trained person-years from a cohort by increasing the fraction of reenlistments into the second term that chooses a six-year (rather than a four-year) term of enlistment.

Figure 4.1 shows the relative importance of each of these three types of behavior to the overall effect of zone A bonuses. The complete bars show the percentage increase in the trained-person-years from a cohort resulting from zone A bonuses. The components of each bar indicate the sources of the increase.

Roughly two-thirds of the overall force increase caused by zone A bonuses is due to the CAREERS Program effect. The remaining third is

Table 4.5

PROBABILITY OF CHOOSING A FOUR-YEAR TERM OF ENLISTMENT
(Given a decision to reenlist)

Bonus Multiple	Second Term		Career Terms	
	From Four-Year First Term	From Six-Year Second Term	From Zone B	From Zone C
0	0.911	0.694	0.831	0.816
1	0.355	0.135	0.154	0.450
2	0.279	0.059	0.154	0.450
3	0.203	0.000	0.154	0.450
4	0.127	0.000	0.154	0.450
5	0.051	0.000	0.154	0.450
6	0.000	0.000	0.154	0.450

SOURCE: Grace Carter's econometric analyses for the EFMP's Middle Term Disaggregate IPM.

NOTE: These estimates assume no cap on bonus payments (to be used in simulations where the bonus is below the cap, or where the effect of an uncapped bonus is being tested).

divided approximately evenly between the reenlistment effect and the term-of-enlistment effect.

The figure was constructed by running the ALEC model to analyze the total effect of zone A bonuses on force size, then rerunning it after disabling the part of the model that lets the zone A bonus affect CAREERS Program flows, and then running it again after additionally disabling the part of the model that lets zone A bonuses affect the term-of-enlistment choice.
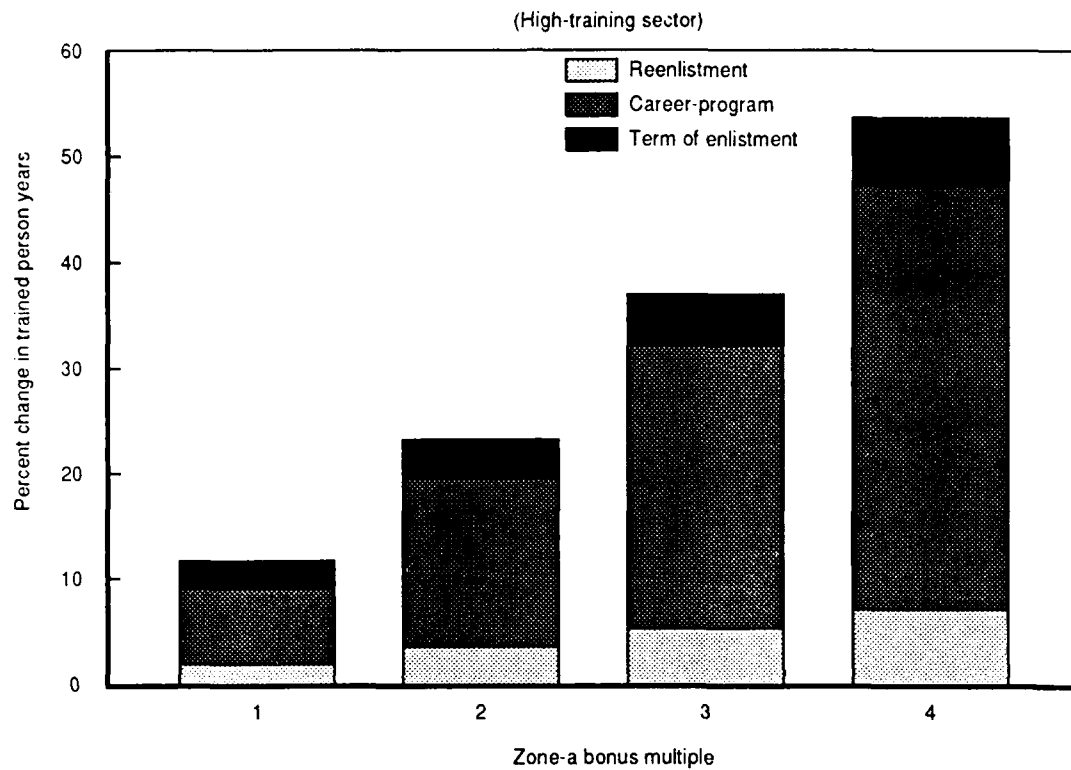
Fig. 4.1 -- Effect of zone A reenlistment bonuses on force size--in
the average specialty in the high training sector, by cause:
additional reenlistments, altered CAREERS Program flows,
increased term of enlistment

V. EFFECTIVENESS MEASURES

For policy analyses, the costs must be normalized by a measure of effectiveness. The basic measure of effectiveness used this analysis is the trained-person-year--a full year of work done by an enlisted person who has completed training. "Completion of training" means that the person has completed basic military training, any technical schools required for a given specialty, and the training portion of the on-the-job training period.

Using the trained-person-year measure, the additional costs caused by an action such as a reenlistment bonus can be expressed as the cost per additional trained-person-year caused by that action.

However, the trained-person-year measure has a serious limitation. It does not account for productivity increases with experience. For example, if the mid-career trained-person-years added by the reenlistment bonus are more productive than the average trained-person-year added by accessions, then the cost effectiveness of reenlistment bonuses will be underestimated relative to accessions.

Estimates of productivity increases with experience are not currently available by specialty, and producing such estimates is beyond the scope of this research. Rather than assume that such productivity increases do not exist (which would be the effect of uncritically adopting the trained-person-year measure of effectiveness), this analysis explores the effect of alternative estimates of the productivity increase.

The ALEC model reports the cost effectiveness of management actions for a range of productivity increases with experience. Managers of specific specialties should have sufficient subjective knowledge of productivity increases in their particular specialty to decide which part of the productivity-increase range is relevant to them.

The point is that enlisted force managers cannot give specific estimates of productivity increases with experience, but they may well know whether it is greater or less than some critical value that ALEC shows is the threshold for choosing between one action and another.

COST PER TRAINED-PERSON-YEAR

A given action creates additional costs at various points during a cohort's life cycle, and it creates additional trained-person-years at other points. If the added costs in any given year were proportional to the additional trained-person-years, then the ratio in any year would be the desired cost effectiveness ratio.

However, the additional costs tend to be distributed differently from the additional trained-person-years. We therefore need to average the yearly ratios to get a single overall cost effectiveness measure. When doing this averaging, we weight each yearly ratio by the number of trained-person-years in that year, and we discount all the ratios to the beginning of the lifecycle.

$$r = \sum_y [t(y)/\sum_y t(y) D(y)] [c(y)/t(y)] D(y) \qquad (5.1)$$

where
r = cost per trained person-year,
$c(y)$ = additional cost in lifecycle year y,
$t(y)$ = additional trained persons in lifecycle year y,
$D(y)$ = discount factor that brings costs and effectiveness back to the beginning of the lifecycle.

The resulting formula can be more simply expressed as the discounted sum of additional costs during the lifecycle divided by the discounted sum of additional trained person-years during the lifecycle.

$$r = [\sum_y c(y) D(y)]/[\sum_y t(y) D(y)] \qquad (5.2)$$

Multiplying both sides of this equation by the denominator on the right hand side produces a third interpretation of the cost per trained-person-year, r.

$$\sum_y r\, t(y) D(y) = \sum_y c(y) D(y) \qquad (5.3)$$

This third equation shows that "r" is the level amount that must be paid for each trained-person-year of work done by the enlisted force to cover all costs during the cohort's lifecycle.

Only part of the level payment of "r" for each trained-person-year would go to enlisted persons as compensation; the rest would go into a bank account that would be drawn upon to pay for training costs, reenlistment bonuses, and retirement benefits. (This hypothetical bank account would go into debt in the early years of a cohort's lifecycle as training costs occurred, then it would build up a positive balance during the middle and late years to be in a position to fund retirement benefits.)

PRODUCTIVITY DURING OJT

Recall from the previous section's discussion of OJT that only part of the OJT period is spent in training, with the rest spent doing productive work. Person-years in the working part of the OJT period are counted as trained-person-years when measuring effectiveness. Accordingly, we need a formula that shows how the fraction of the OJT period spent in actual training affects the number of trained-person-years generated by a given action.

$$t(y) = [1 - a] [t1(y)] + t2(y) \qquad (5.4)$$

where $t1(y)$ = additional person-years in the OJT period during lifecycle year y,
$t2(y)$ = additional person-years post OJT during lifecycle year y,
a = fraction of OJT period spent in training.

PRODUCTIVITY INCREASES WITH EXPERIENCE

This analysis does not know how much productivity increases with experience. Rather, it constructs a one-parameter system of experience weights with which the effect of productivity increases on conclusions can be assessed.

Linear Experience Weights

The weighting system used is linear. That is, trained-person-years at a given point in the lifecycle are given a weight that depends on that point in the lifecycle but is independent of the number of trained person-years at other points.

$$e(y) = w(y,b) \ t(y) \qquad (5.5)$$

where $e(y)$ = additional effectiveness during lifecycle year y,
$w(y,b)$ = productivity of trained persons with y years of service,
b = weighting system parameter (the larger "b", the more productivity increases with experience).

The restriction to linear weighting systems is not a serious limitation. Recall that this analysis emphasizes the marginal effects of management actions; therefore, it needs to measure only the effectiveness of small changes in trained-person-years, which can be approximated by a linear effectiveness function no matter what the global effectiveness function looks like. This conclusion follows from the fact that the effect of small changes in the arguments of any function can be approximated by the sum of the changes in arguments times the derivatives of the function with respect to the arguments.

$$E(X + x, Z + z) - E(X,Z) = x \ dE/dX + z \ dE/dZ \qquad (5.6)$$

where $E(X,Z)$ = global effectiveness of trained persons X and Z, at different points in the lifecycle, where x and z are changes in the numbers of those trained persons

Increase in Weights Proportional to Increase in Pay

The specific linear weighting system used in this analysis makes the proportional increase in weights during the lifecycle be a multiple, b, times the proportional increase in the total pay received by enlisted personnel (see Fig. 5.1).
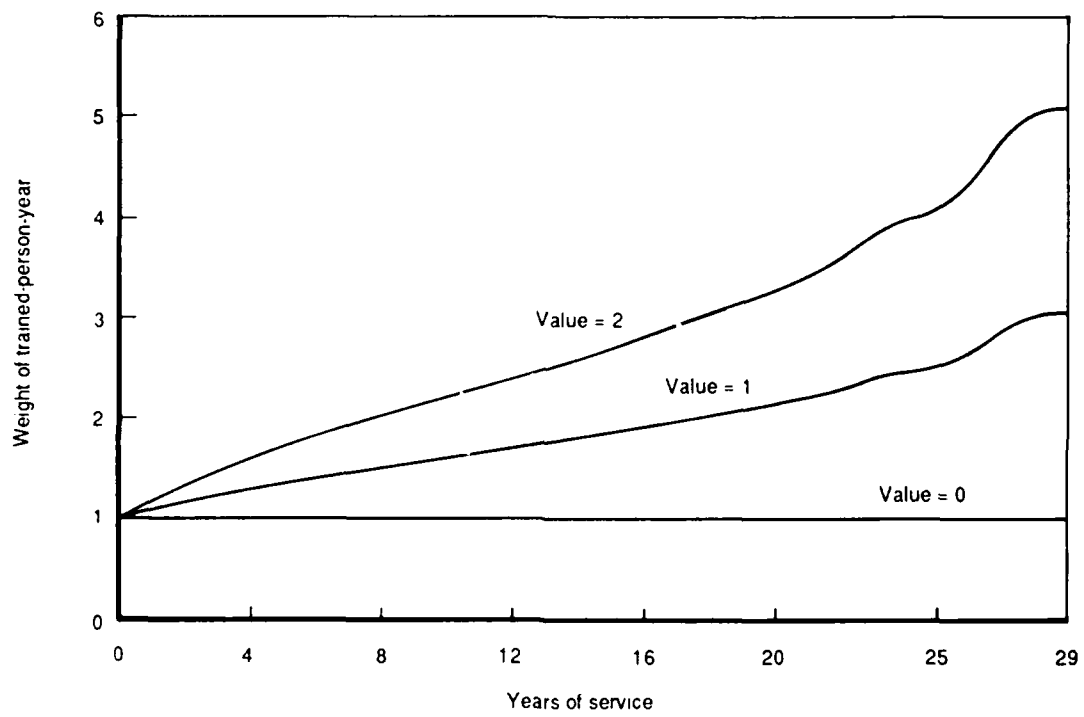
Fig. 5.1 -- Experience weights by years of service

$$[w(y,b) - w(y,o)]/w(o) = b[p(y) - p(o)]/p(o) \qquad (5.7)$$

where b = percent increase in experience weight per 1 percent
             increase in pay with experience,
        $p(y)$ = pay received by persons with y years of service, in
             constant dollars.

If the weighting parameter, b, equals 0, then weights do not change
at all with experience, and the measure of effectiveness remains the
unweighted trained-person-year.

If the weighting parameter, b, equals 1, then the experience
weights increase in proportion to pay. This weighting scheme may well
be the correct one on average because the pay increases with years of
service have presumably been established to at least roughly recognize
productivity increases with experience.

However, even if $b = 1$ is the correct weighting parameter to use
for the average specialty, for a particular specialty the appropriate
value may be more or less than 1.

This analysis considers all values of "b" from 0 to 2. When $b = 2$,
the weighting system says that experience is so valued in a given
specialty that it increases twice as fast as pay does with years of
service.

Figure 5.1 graphs the weights that result from $b = 0$, $b = 1$, and
$b = 2$. In the graph these parameter values are referred to as "Value =
0," "Value = 1," and "Value = 2," indicating that the value of increased
experience is that multiple of increased pay.

The level curve in the figure is the weighting system that results
if experience has no value (so the measure of effectiveness is the
unweighted trained-person-year).

The middle curve in the figure is the weighting system that results
if increased experience with years of service is judged to be
proportional to increased pay with years of service. This is the
weighting system that obeys the rule of thumb that a person who receives
20 percent more pay than at YOS = 0 is 20 percent m re effective than at
YOS = 0.

The top curve in the figure is the weighting system that results if the value of increased experience is judged to be proportional to twice the increased pay. With these weights, a person earning 20 percent more than at YOS = 0 is judged to be 40 percent more productive than at YOS = 0

Calculation of the Weights

Solving the equation defining the weighting system shows that the weight for a particular number of years of service, y, and for a particular parameter, b, is:

$$w(y,b) = w(o,b) + bw(o,b)[p(y)/p(o) - 1] \qquad (5.8)$$

This can be simplified by choosing $w(o,b) = 1$ to define the units in which the weights will be measured. In other words, productivity of a trained-person-year is measured relative to the productivity of a trained-person-year at the start of the lifecycle.

$$w(y,b) = 1 + b[p(y)/p(o) - 1] \qquad (5.9)$$

Next, note that

$$w(y,1) = p(y)/p(o) \qquad (5.10)$$

so that

$$w(y,b) = [1 - b] + bw(y,1) \qquad (5.11)$$

and

$$\sum_y e(y)D(y) = [1 - b] \sum_y t(y)D(y) + b \sum_y w(y,1)t(y)D(y) \qquad (5.12)$$

This last equation says that to calculate discounted effectiveness over the lifecycle for any value of the weighting parameter, b, we need calculate it only for b = 0 and b = 1, and then combine the two results weighting the first by "1 - b" and the second by "b." This result makes ALEC's job of exploring the entire range of weighting parameters much easier.

COST EFFECTIVENESS RELATIVE TO REFERENCE CASE

The problem with considering alternative weighting systems is that cost effectiveness estimated with one system cannot be directly compared with cost effectiveness estimated with another. In our specific case, as the weighting parameter, b, increases, the weights increase and measured cost effectiveness will decrease. So if we value experience greatly (choose a high value of b), an action will have a misleadingly low cost effectiveness ratio.

The cure for this problem is to choose one action as a reference case and express the cost effectiveness of all other actions relative to that case. In this analysis, we choose NPS accessions for a four-year term of enlistment as the reference case because it is by far the dominant method of adding to the enlisted force. We refer to this reference action as NPS4.

In other words, all cost effectiveness measures are normalized by dividing them by cost effectiveness of the NPS4 action (with the same weighting parameter, b, used in both instances).

Now the cost effectiveness results can be compared for alternative values of "b." No matter what the value of experience, the interpretation of the normalized cost effectiveness measure is the same.

For actions that increase the enlisted force: If the ratio is greater than 1, the action being evaluated is less cost effective than NPS4. If the ratio equals 1, then the action has the same cost effectiveness and NPS4. If the ratio is less than 1, the action is more cost effective than NPS4.

For actions that decrease the enlisted force, the interpretation reverses because then we want to save as much cost as possible for the forgone effectiveness. If the ratio is greater than 1, the action being

evaluated is more cost effective than NPS4. If the ratio equals 1, the
action has the same cost effectiveness as NPS4. If the ratio is less
than 1, the action is less cost effective than NPS4.

VI. COST COMPONENTS

This section defines the components of personnel cost and presents the theory necessary to estimate those components. Two rules have been followed in the definition of the components and construction of the theory.

Rule 1: Trace all the cost changes caused by an action so that the estimated cost effectiveness is unbiased.

Rule 2: Hold cost effectiveness constant in the rest of the force when an action applied to a specialty also affects the rest of the force.

The first rule requires that training costs at the start and retirement costs at the end of a cohort's lifecycle be included in the analysis as well as the pay and reenlistment bonuses during the cohort's lifecycle. The first rule also requires that cost of support specialties be included in the cost of nonsupport specialties.

The second rule requires that a specialty receiving a crossflow from an origin specialty must compensate that origin specialty for giving up the valuable experienced personnel, and that a specialty sending a crossflow to a destination specialty must receive a payment from that destination specialty for receiving the valuable experienced personnel.

These payments among specialties are called "crossflow fees" in this analysis. Of course, such payments do not actually occur in the sense that money changes hands. However, the costs that they reflect are real. For example, if a senior person is sent from specialty A to specialty B, then specialty B saves the money needed to "grow" an additional senior person. The crossflow fees provide an accounting mechanism for that cost saving in specialty B to be credited to the management action in specialty A that caused the saving.

Accordingly, this analysis defines the total cost of a cohort over its lifecycle as the sum of six components:

- Training cost
- Trained-person-pay
- Reenlistment bonuses
- Retirement benefits
- Support costs
- Crossflow fees

All cost estimates are in Fiscal Year 1984 dollars. The bottom line of this analysis will be cost of a management action relative to a reference action, so the choice of fiscal year in which to express dollar amounts ultimately does not matter. However, it is important that cost estimates be internally consistent, so the same reference year must be used throughout the cost estimation methodology.

TRAINING COST

Enlisted personnel receive three kinds of training:

- Basic Military Training (BMT)
- Technical school
- On the Job Training (OJT)

BMT takes six weeks. Technical school typically takes a few months. OJT typically takes about three-fourths of a year. Technical school duration varies from zero in specialties that do not require technical training to over a year in very complex specialties. Average OJT durations by specialty vary from one-half a year to a full year. Volume 2, App. A, lists durations of formal training (BMT plus any technical school) and OJT by specialty.

Training requirements for individuals entering a specialty depend upon the route chosen. NPS accessions go through the complete training program. PS accessions that do not require retraining do not participate in any part of the training program (because they have just recently received the training). PS accessions that require retraining go through technical school and OJT. Finally, crossflows from one specialty to another go through technical school and OJT.

Cost of Formal Training

Formal training consists of Basic Military Training and any technical schools required for entry to a given Air Force specialty. This analysis estimates the cost of formal training by using standard Air Force cost factors for the "acquisition cost" of graduates from formal training. That cost includes:[1]

a. Cost per graduate for training courses required for a specific AFSC at the basic skill level.

b. Acquisition costs (inluding the costs of recruiting, initial travel, initial clothing issued) and the cost for basic training at the Air Force Military Training Center.

c. Pay and allowances while awaiting pretechnical training assignment. (Includes cases when no formal training is required.)

d. Permanent change of station (PCS) costs for each AFSC after completing training at the Military Training Center when no formal training is required or when an enlisted member goes directly to his or her first duty station.

e. Pay and allowances for leave accrued during basic training, time required in pretechnical training status, and time in technical school.

This analysis estimates the cost of basic military training by the cost of formal training in specialties that do not require technical schools. Then it estimates the cost of technical schools, by specialty, as the total cost of formal training less the cost of basic military training.

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[1]*U.S. Air Force Cost and Planning Factors*, Department of the Air Force, AF Regulation 173-13, February 1985, p. 31.

Cost of OJT

The OJT component of training cost is difficult to estimate because persons in OJT spend part of their time learning how to do the job and part of their time doing the job. Only the learning part is a training cost.

The fraction of the OJT period spent in actual training, as opposed to doing productive work, is not known exactly (it is even difficult to define operationally). However, a consensus has emerged that 40 percent training and 60 percent work is an adequate description of behavior during the OJT period for modeling the enlisted force.

At least two research efforts have shed considerable light on this question. Gay and Albrecht (1979) did an exploratory study for a few representative job specialties. Their work showed that productivity as a function of time in OJT tends to start at zero, rise continuously, and reach 100 percent of trained-person productivity only at the end of the OJT period. Moreover, their productivity curves were always bowed upward from a straight line connecting zero productivity at the start of OJT and full productivity at the end of OJT. These results suggest that the fraction of OJT time spent in training is slightly less than 50 percent.

In their analysis of the replacement cost of trained Air Force personnel, Fleming et al. (1987) decided that the evidence accumulated to date supports a point estimate of 40 percent training time during the OJT period.

Accordingly, this analysis estimates the OJT component of training cost by multiplying the compensation paid to persons in OJT by 0.4. Note that instructor costs are not modeled separately in this analysis. Instead the analysis assumes that the 40 percent estimate of lost productivity of trainees during the OJT period has been set high enough to cover any lost productivity of instructors. Appendix C explores the sensitivity of cost effectiveness conclusions to this parameter estimate.

TRAINED-PERSON-PAY

"Pay" in this analysis is the sum of "basic pay" and "other pay," where the second component consists of the basic allowance for quarters, the basic allowance for subsistence, and the federal tax advantage on the tax free allowances.

"Trained-person-pay" is the pay received by trained persons (persons who have completed BMT, technical school, and the training portion of their OJT period). Pay received by persons in training is included in training costs.

Note that the estimate of pay in this analysis does not include a retirement component. Retirement benefits are a separate category in this analysis.

Military pay varies by pay grade and by years of service. However, pay grade tends to increase with years of service, so the pay table can be summarized by its distribution by years of service (see Table 6.1).[2] The FY84 distribution of personnel by grade in each year of service was used to compute average pay by years of service in Table 6.1.

Four-year enlistees enter at grade E1, are promoted from grade E2 at six months, to grade E3 at 16 months, and to grade E4 at 36 months. Six-year enlistees enter at grade E3 and are promoted to grade E4 at 28 months. (Promotions beyond grade E4 depend upon performance, rather than time in service itself.) Consequently, pay during the first few years of service is different for four- and six-year enlistees.[3]

Table 6.2 shows the differental pay received by four- and six-year enlistees during the first three years in the service. The pay in this table is the appropriate weighted average of grade-specific amounts.

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[2] ALEC keeps track of years of service during a cohort's lifecyle, so it can use the information in Table 6.1. It does not keep track of pav grade, so it cannot use a full pay table.

[3] ALEC needs to keep track of this initial pay differential by term of enlistment in order to correctly model the cost effectiveness of six-year NPS accessions relative to four-year NPS accessions.

Table 6.1

COMPENSATION OF ENLISTED PERSONNEL
BY YEARS OF SERVICE

(Annual pay January 1, 1984)

| Years of Service | Compensation | | |
	Basic Pay	Other Pay	Total
0	7669	4246	11914
1	8308	4539	12847
2	8862	4667	13528
3	9393	5166	14559
4	10093	5312	15405
5	10900	5442	16342
6	11042	5580	16622
7	11906	5822	17728
8	12061	5933	17993
9	12669	6032	18701
10	12816	6099	18915
11	13294	6352	19647
12	13540	6411	19951
13	14562	6413	20975
14	14818	6505	21323
15	15603	6649	22252
16	15910	6750	22660
17	16747	6870	23617
18	17192	6995	24187
19	18056	7139	25195
20	18159	7167	25325
21	19090	7373	26463
22	19482	7473	26955
23	21515	7769	29284
24	21984	7889	29874
25	22208	7947	30155
26	23789	8354	32143
27	26507	8638	35145
28	27636	8936	36572
29	27636	8936	36572

SOURCE: Gordon (1984). "Other pay"
is allowances for quarters and subsis-
tance. Pay by grade is averaged across
all grades for each year of service,
using the distribution of grades within
each year of service.

Table 6.2

COMPENSATION OF ENLISTED PERSONNEL
DURING FIRST THREE YEARS IN SERVICE
BY TERM OF ENLISTMENT

(Annual pay January 1, 1984)

| Years of Service | Compensation | | |
	Basic Pay	Other Pay	Total
Four-year Term of Enlistment			
0	7584	4188	11772
1	8259	4496	12755
2	8784	4592	13376
Six-year Term of Enlistment			
0	8340	4568	12908
1	8340	4568	12908
2	9162	4954	14116

SOURCE: Gordon (1984). "Other pay" is allowances for quarters and subsistance. Pay by grade is averaged across all grades for each year of service, using the distribution of grades within each year of service.

REENLISTMENT BONUS PAYMENTS

Reenlistment bonuses are offered to selected specialties to encourage reenlistments. Persons who reenlist into a new specialty receive a bonus if one is offered in that specialty. PS accessions do not receive reenlistment bonuses.

To enable targeting on different parts of the lifecycle, the bonuses are offered separately to three different years of service ranges. Zone A bonuses are offered to years of service 2 through 5, zone B bonuses to years of service 6 through 9, and zone C bonuses to years of service 10 through 13. (A person has zero years of service during the first year in the enlisted force, so the zone A bonus can be

claimed by persons who reenlist before the end of their sixth year of service.)

The size of a reenlistment bonus is described by a "bonus multiple." One speaks of a zone A bonus equal to 2, where 2 is the multiple. The dollar amount of the bonus is proportional to this multiple.

The complete formula for a reenlistment bonus is: bonus multiple times monthly basic pay at time of reenlistment times the number of years in the new term of enlistment. If a person reenlists for a four-year term when the bonus multiple is 1, the reenlistment bonus is four times the monthly basic pay. If a person reenlists for a six-year term when the bonus multiple is 2, the reenlistment bonus is 12 times the monthly basic pay. Three-fourths of the bonus is paid at the time of reenlistment, the remainder is paid in annual installments over the term of enlistment.

Not surprisingly, given that the reenlistment bonus is proportional to the term of enlistment, the probability that an enlisted person will reenlist for a six-year term (rather than a four-year term) increases as the reenlistment bonus increases. (See Sec. IV.)

RETIREMENT BENEFITS

ALEC accounts for retirement benefits by estimating the present value of expected retirement payments at the time that an enlisted person retires. This is done by tracking the retiring cohort year by year into the future, paying the survivors their retirement benefits each year, and then computing the discounted sum.

The monthly retirement benefit equals the monthly basic pay at the time of retirement times a fraction that varies from 0.50 to 0.75 as the number of years of service at retirement varies from 20 to 30.

In other words, an enlisted person who retires after 20 years of service (the earliest time that retirement benefits are available) receives 50 percent of basic pay. A person retiring after 21 years of service receives 52.5 percent of basic pay. The percentage increases by 2.5 for each year of service until it reaches 75 percent of basic pay at 30 years of service (the mandatory retirement point).

SUPPORT COSTS

The support sector includes all the specialties whose total strength is determined by the size of the enlisted force, rather than by the missions that the enlisted force is designed to accomplish. In other words, the support specialties exist because the other specialties exist. This being so, the cost of the support sector is a cost that should be allocated to the nonsupport sectors.

The importance of this allocation for cost effectiveness analysis lies in the following observation. Persons require support when they are in training as well as after they have been trained.

An action that adds trained persons without increasing training loads (for example, reenlistment bonuses) adds less to support costs than an action that adds the same number of trained persons but also adds to training loads (for example, accessions). If this analysis did not allocate support costs to the nonsupport specialties, then the estimated cost effectiveness of the first action would be overestimated relative to the second.

The ALEC model traces a cohort from recruitment to retirement. Each person-year in the cohort's lifecycle requires support by the support sector. The model estimates the cost of that support by multiplying person-years at each stage of the lifecycle by the support cost per person year, S.

To find this support cost per enlisted-person-year we first recognize that it is the product of the number of trained support persons required and the cost per trained support person:

$$S = N(Cs) \tag{6.1}$$

S = annual support cost per person in the enlisted force,

N = number of trained support persons required to support a person in the enlisted force,

Cs = annual cost per trained support person.

The number of trained persons in the support sector that are required per enlisted person can be estimated from observed end strengths:

$$N = (Ts)(Es)/E \qquad\qquad (6.2)$$

where N = number of trained support persons required to support a person in the enlisted force,

Ts = trained persons per person in the support sector,

Es = end strength in the support sector,

E = end strength across all sectors.

Estimating the cost per trained support person is complicated by the fact that persons in the support sector also require support, and the cost of that support depends upon the cost per trained support person. The answer requires solving two simultaneous equations.

Combining the above equations produces the first of the required equations:

$$S = (Cs)(Ts)(Es)/E \qquad\qquad (6.3)$$

To get the second equation, we first look at cost in a particular specialty in the support sector, and then average over all such specialties.

In a support sector specialty, as in any specialty in the enlisted force, the total cost per trained person equals the partial cost (cost excluding support) plus the support cost. All these costs are per trained-person-year, so the support cost, S (which is per person-year), must be divided by trained persons per person before being entered into this equation.

$$Cs_i = Ps_i + S/Ts \qquad\qquad (6.4)$$

Cs_i = annual cost per trained person in support specialty i,

Ps_i = partial annual cost per trained-person-year in support specialty i (cost excluding support costs).

Averaging over all specialties in the support sector produces the second equation:

$$Cs = Ps + S/(Ts) \qquad\qquad (6.5)$$

    Ps = partial annual cost per trained-person-year in the support
        sector (cost excluding support costs).

Solving the two simultaneous equations shows that the annual support
cost per person in the enlisted force equals the partial cost per
trained support person expanded by the number of trained support persons
per nonsupport person:

$$S = (Ps)(Ts)[(Es)/[E - (Es)] \qquad\qquad (6.6)$$

    Using the ALEC model to analyze the support sector yields the
following estimates, in FY84 dollars, Ps = \$21,419, Ts = .9114,
Es/(E - Es) = .3643. Using those estimates in Eq. (6.6) yields the
estimate that the annual support cost, S, per enlisted person is \$7,112.

CROSSFLOW FEES

    When analyzing the cost effectiveness of management actions for a
given specialty, we want to hold the cost effectiveness of all other
specialties constant. This presents a problem when actions cause
crossflows among specialties because such flows affect cost and
effectiveness in both the "action specialty" (the one being analyzed),
and the "other specialty" (the one that either supplies the inflow to or
absorbs the outflow from the action specialty).

    This analysis solves this problem by adding NPS accessions to the
other specialty or subtracting them to hold effectiveness constant and
by having the action specialty pay the compensation to the other
specialty for inflows and receive compensation for outflows.

    Obviously, the crossflow fees are needed to correctly measure the
costs of the retraining actions (retraining into and out of a
specialty).

    Not so obviously, they are also needed to correctly measure the
cost of zone A bonuses. Zone A bonuses affect the crossflows in the
CAREERS Program. Inflow fees must be paid for the additional inflows to

the action specialty caused by zone A bonuses, and outflow fees must be given up for the decreased outflows from the action specialty caused by zone A bonuses.

Similarly, crossflow fees are needed to assess the cost of CJRs. The reservations on a specialty's own reenlistments cause additional outflows from the specialty (see Sec. IV), and outflow fees must be received for those additions. The reservations on retrainees into a specialty reduce inflows, and inflow fees must be given up for those reductions.

Inflow Fee

For an inflow of retrainees, the action specialty pays the source specialty an amount per retrainee (called the "inflow fee") that compensates the source specialty for the net costs of holding effectiveness constant by adding accessions.

To get a formula for the inflow fee, we look at the source specialty and analyze the present values of cost and effectiveness for the departing retrainees and for the replacement accessions.

The effectiveness from the replacement accessions must equal the effectiveness from the lost retrainees:

$$(Ea)A = (E_i)(R_i) \qquad (6.7)$$

where R_i = retrainees who leave the source specialty at a specified point in the lifecycle (e.g. at YOS = 4);

E_i = present value of all the effectiveness that would have occurred in the source specialty if the retrainees had not left the source specialty, per retrainee;

A = additional accessions needed to hold effectiveness constant;

Ea = effectiveness of the accessions over their lifecycle, per accession.

The cost of the replacement accessions, less the compensation fee received by the source specialty, must equal the cost savings from the lost retrainees:

$$(Ca)A - (F_i)(R_i) = (C_i)(R_i) \qquad (6.8)$$

where F_i = inflow fee per retrainee flowing from the source specialty to the action specialty (paid by the action specialty to the source specialty);

C_i = present value of all costs that would have occurred in the source specialty if the retrainees stayed in the source specialty, per retrainee;

Ca = cost of the accessions over their lifecycle, per accession.

Solving those two equations for the required compensation payment:

$$F_i = [(Ca)(E_i)/(Ea)] - C_i \tag{6.9}$$

Outflow Fee

For an outflow of retrainees, the action specialty receives from the destination specialty an amount per retrainee (called the "outflow fee") that equals the cost savings in the destination specialty from substituting retrainees for accessions.

To get a formula for the import fee, we look at the destination specialty and analyze the present values of cost and effectiveness for the arriving retrainees and for the forgone accessions.

The effectiveness from the reduced accessions must equal the effectiveness from the gained retrainees:

$$(Ea)A = (E_o)(R_o) \tag{6.10}$$

where R_o = retrainees who join the destination specialty at a specified point in the lifecycle (e.g. at YOS = 4);

E_o = present value of all the effectiveness that occurs in the destination specialty because of the inflow of retrainees (including the reduced effectiveness during retraining), per retrainee;

A = reduction in accessions needed to hold effectiveness constant;

Ea = effectiveness of the accessions over their lifecycle, per accession.

The savings from the reduced accessions must equal the cost of the

gained retrainees plus the fee paid by the destination specialty for the retrainees:

$$(Ca)A = (C_o)(R_o) + (F_o)(R_o) \qquad (6.11)$$

where F_o = outflow fee per retrainee from the action specialty to the destination specialty (received by the action specialty from the destination specialty);

C_o = present value of all costs that occur in the destination specialty because of the inflow of retrainees (including the retraining cost), per retrainee;

Ca = cost of the accessions over their lifecycle, per accession.

Solving those two equations for the required compensation payment:

$$F_o = [(Ca)(E_o)/(Ea)] - C_o \qquad (6.12)$$

Tables 6.3 through 6.5 present the inflow fees paid origin specialties to hold the origin specialties harmless and the outflow fees received from destination specialties to hold the destination specialties benefitless.

The tables report the fees by the characteristics of the origin and destination specialties. The sector characteristic indicates training level (see App. A). The value of experience characteristic is made explicit by a weighting system parameter that varies from 0 to 2, where a value = 0 indicates that all experience levels have the same weight and a value = 1 indicates an average value of experience (see Sec. V).

To keep the two fees straight, remember they are named from the viewpoint of the action specialty that is causing the flow. The inflow fee is paid by the action specialty to get an inflow. However, to the source specialty it is a fee received for a loss. Similarly, the outflow fee is received by the action specialty to give up an outflow. However, to the destination specialty it is a fee paid for a gain.

Note that the fees are sometimes negative. A negative inflow fee means that a loss to the origin specialty is a benefit not a liability. This occurs when the value of experience is so low that senior personnel

Table 6.3

INFLOW AND OUTFLOW FEES AT YEAR OF SERVICE 4 BY CHARACTERISTICS
OF THE INFLOW ORIGIN AND OUTFLOW DESTINATION

(Thousands of FY1984 $)

| Value of Experience | Sector | | | | Weighted Average Across all Sectors |
	Support	Low Training	Moderate Training	High Training	
Inflow Fee Paid to Origin Specialty					
0.0	-21.5	-29.6	-19.0	17.0	-16.0
0.5	6.0	1.0	12.2	47.2	13.9
1.0	26.0	24.1	35.4	69.0	36.0
1.5	41.3	42.1	53.3	85.6	53.0
2.0	53.2	56.6	67.5	98.5	66.4
Outflow Fee Received from Destination Specialty					
0.0	-36.1	-42.2	-38.0	-23.1	-35.9
0.5	-8.4	-11.7	-6.8	8.1	-5.8
1.0	11.7	11.3	16.4	30.7	16.4
1.5	27.0	29.3	34.3	47.7	33.5
2.0	39.0	43.7	48.5	61.1	47.0

SOURCE: Analyses with the ALEC model to implement Eqs. 6.9
and 6.12. Fees estimated by those equations are present
values at the start of a cohort's lifecycle. For this table,
the fees were inflated at 4 percent per year to YOS 4.

NOTE: The inflow fee equals the cost of the loss to the
origin specialty, and the outflow fee equals the value of the
gain to the destination specialty.

cost more in pay than they are worth in effectiveness. A negative
outflow fee means that a gain to a specialty is a liability not a
benefit. This occurs when the value of experience is so low that senior
personnel cost more in pay plus retraining costs than they are worth in
effectiveness.

Table 6.4

INFLOW AND OUTFLOW FEES AT YEAR OF SERVICE 8 BY CHARACTERISTICS
OF THE INFLOW ORIGIN AND OUTFLOW DESTINATION

(Thousands of FY1984 $)

Value of Experience	Sector				Weighted Average Across all Sectors
	Support	Low Training	Moderate Training	High Training	
Inflow Fee Paid to Origin Specialty					
0.0	-79.4	-91.3	-78.7	-41.9	-75.5
0.5	-29.9	-37.3	-24.1	16.0	-21.9
1.0	6.2	3.4	16.4	57.9	17.8
1.5	33.5	35.2	47.6	89.6	48.2
2.0	55.0	60.7	72.5	114.4	72.3
Outflow Fee Received from Destination Specialty					
0.0	-94.1	-104.0	-97.9	-82.2	-95.6
0.5	-45.5	-51.1	-44.7	-26.6	-43.3
1.0	-10.1	-11.3	-5.3	13.6	-4.7
1.5	16.7	19.8	25.2	44.1	24.9
2.0	37.8	44.8	49.2	67.9	48.3

SOURCE: Analyses with the ALEC model to implement Eqs. 6.9
and 6.12. Fees estimated by those equations are present
values at the start of a cohort's lifecycle. For this table,
the fees were inflated at 4 percent per year to YOS 8.

NOTE: The inflow fee equals the cost of the loss to the
origin specialty, and the outflow fee equals the value of the
gain to the destination specialty.

If retraining were costless and did not reduce effectiveness during
the retraining period, then the inflow fee would equal the outflow fee.
Note that the Eq. (6.9) for F_i and Eq. (6.12) for F_o are the same except
for the "o" and "i" indexes.

However, the cost of retraining makes C_o larger than C_i, and the
lost effectiveness during retraining makes E_o smaller than E_i. So the

Table 6.5

INFLOW AND OUTFLOW FEES AT YEAR OF SERVICE 12 BY CHARACTERISTICS
OF THE INFLOW ORIGIN AND OUTFLOW DESTINATION

(Thousands of FY1984 $)

| Value of Experience | Sector | | | | Weighted Average Across all Sectors |
	Support	Low Training	Moderate Training	High Training	
Inflow Fee Paid to Origin Specialty					
0.0	-129.9	-139.7	-128.4	-99.0	-126.4
0.5	-74.6	-81.1	-69.5	-34.6	-67.6
1.0	-34.4	-37.0	-25.9	11.9	-24.3
1.5	-3.8	-2.5	7.9	47.2	9.1
2.0	20.1	25.3	34.7	74.8	35.5
Outflow Fee Received from Destination Specialty					
0.0	-144.6	-152.4	-147.6	-139.0	-146.5
0.5	-91.1	-95.8	-91.4	-80.0	-90.4
1.0	-52.3	-53.2	-49.6	-37.0	-49.0
1.5	-22.8	-19.9	-17.4	-4.5	-17.2
2.0	0.4	6.9	8.2	20.9	8.0

SOURCE: Analyses with the ALEC model to implement Eqs. 6.9 and 6.12. Fees estimated by those equations are present values at the start of a cohort's lifecycle. For this table, the fees were inflated at 4 percent per year to YOS 12.

NOTE: The inflow fee equals the cost of the loss to the origin specialty, and the outflow fee equals the value of the gain to the destination specialty.

inflow fee that a specialty earns as a source for inflows to an action specialty is always larger than the outflow fee that a specialty pays as a destination for outflows from an action specialty.

In other words, a specialty loses more when it gives up a person than it gains when it acquires a person--with the gap explained by the need to retrain the person it acquires. Tables 6.3 through 6.5 show that the gap between inflow and outflow fees gets larger as the cost of

training increases (holding the value of experience at the origin and destination specialties constant).

The information in Tables 6.3 through 6.5 can be used easily to design retraining programs that increase the overall cost effectiveness of the enlisted force. A retraining flow saves money if the cost of the loss to the origin specialty (top panel in the tables) is less than the value of the gain to the destination specialty (bottom panel in the tables). In other words, managers of the retraining programs should seek to transfer personnel from specialties with fairly low training costs and low values of experience to specialties with fairly high training costs and high values of experience.

However, such use of this information is beyond the scope of this analysis. Rather than optimizing a particular action across the entire force, this analysis supports a model that compares all actions for a particular part of the force. Accordingly we must summarize the above information from the perspective of a particular specialty being analyzed.

Multiple Sources and Destinations

The inflows to a given action specialty come from many origin specialties. The inflow fee for an action specialty is the average of the inflow fees of all the origin specialties:

$$F_i = \sum_k (W_{ik})(F_{ik}) \qquad (6.13)$$

where W_{ik} = fraction of inflow to specialty i coming from specialty k,

F_{ik} = inflow fee paid by specialty i to specialty k.

The outflows from a given action specialty go to many destination specialties. The outflow fee received by an action specialty is the average of the outflow fees from all the destination specialties:

$$F_o = \sum_k (W_{ok})(F_{ok}) \qquad (6.14)$$

where W_{ok} = fraction of outflow from specialty o going to specialty k,

F_{ok} = outflow fee received by specialty i from specialty k.

To estimate the fractions F_{ik} and F_{ok}, this analysis uses the proportion of all enlisted persons who work in the given specialty. In other words, the action specialty is assumed to get its inflow from an average mix of origin specialties and to send its outflow to an average mix of destination specialties. In practice, this analysis does the above weighted averaging of fees over four representative specialties: the average specialties in the support, low training, moderate training, and high training sectors.

The averages across all sectors have already been reported in Tables 6.3 through 6.5. However, for ease of reference, Table 6.6 pulls together the average fees for zero value of experience (value of experience parameter = 0) and average value of experience (value of experience parameter = 1).

Values of Experience Assumed for Crossflows

Table 6.7 presents the inflow and outflow fees used by the ALEC model for crossflows. These fees are the result of assumptions about

Table 6.6

AVERAGE INFLOW AND OUTFLOW FEES

(FY1984 $ per retrainee)

Point in Lifecycle	Average Inflow Fee Paid to Origin	Average Outflow Fee Received from Destination
Zero Value of Experience		
YOS = 4	-16000	-35900
YOS = 8	-75500	-95600
YOS = 12	-126400	-146500
Average Value of Experience		
YOS = 4	36000	16400
YOS = 8	17800	-4700
YOS = 12	-24300	-49000

SOURCE: Tables 6.3 through 6.5.

Table 6.7

INFLOW AND OUTFLOW FEES USED IN THE ALEC MODEL

(FY1984 $ per retrainee)

Point in Lifecycle	Inflow Fee Paid to Origin	Outflow Fee Received from Destination
CAREERS Program		
YOS = 4	36000	16400
Retraining Programs		
YOS = 4	-16000	16400
YOS = 8	-75500	-4700
YOS = 12	-126400	-49000

SOURCE: Table 6.6.

the values of experience at the origins and destinations of the crossflows.

For crossflows generated by the CAREERS Program, the ALEC model assumes that the origins and destinations have average values of experience. Average experience weights are appropriate because in the CAREERS Program, inflows come from and outflows go to a cross section of all specialties.

Similarly, for outflows generated by retraining programs, the ALEC model assumes that the destinations have average values of experience. Again, this is appropriate because those outflows go to a cross section of all specialties. However, for inflows generated by retaining programs, the ALEC model assumes that the origins have zero values of experience. This is appropriate because the specialties that provide the inflows are those with excess senior-level manpower; consequently, the marginal value of experience is approximately zero.

EXAMPLE: COSTS OF NPS ACCESSIONS AND ZONE A BONUSES

To illustrate the cost theory presented in this section, Fig. 6.1 presents the distribution of costs resulting from increasing the force

by adding NPS accessions with a four-year term of enlistment, and Fig. 6.2 presents the distribution of costs resulting from increasing the force by offering a zone A bonus multiple = 1. In both cases, the costs are for the average specialty in the moderate training sector.

These figures were constructed by using the ALEC model to find the present value of the added costs resulting from each management action. Then the distribution of the costs was plotted to get the figures. In other words, these figures say nothing about the overall level of added costs, rather they examine the relative contributions of the cost components.

Comparing the two figures shows that in both cases trained-person-pay is the largest component, and support cost is the second largest component. However, training cost is the third largest component in the cost of NPS accessions, while retirement benefits are the third largest component of zone A bonuses.

Surprisingly, bonus payments are the fourth ranked component in the total cost generated by zone A bonuses. The bonus payments cost only about half as much as the added retirement benefits. This result illustrates the necessity of the lifecycle perspective to capture all costs associated with a management action.

The crossflow fees in both cases result from CAREERS Program flows, as does the training cost generated by the zone A bonus action.
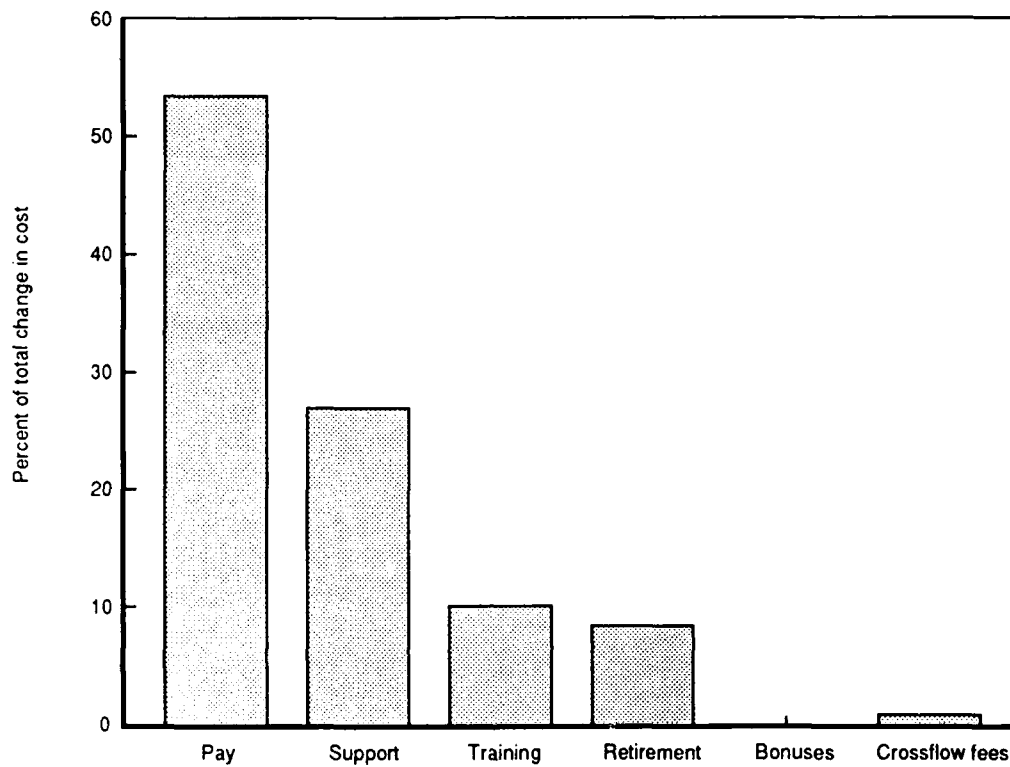
Fig. 6.1 -- Costs of NPS accessions: distribution of
the change in costs resulting from increasing
NPS accessions with a four-year term of enlistment,
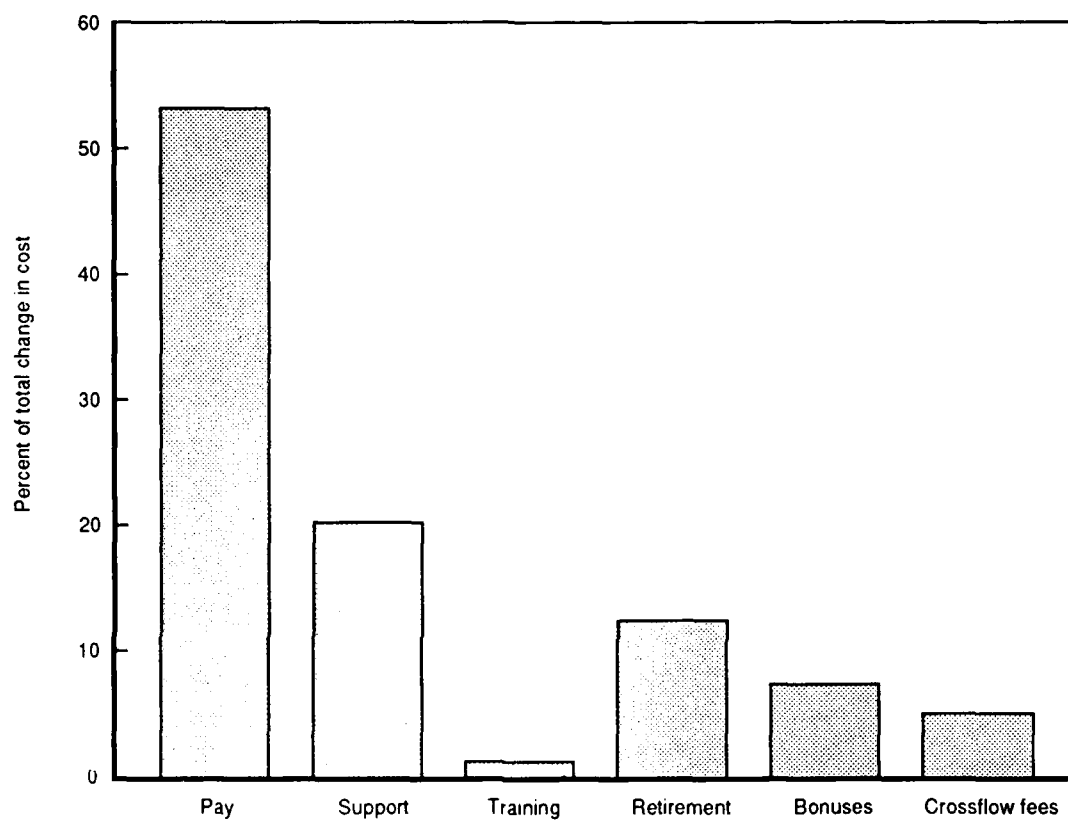average specialty in the moderate training sector

Fig. 6.2 -- Costs of zone A bonuses: distribution of
the change in costs resulting from offering a
zone A bonus multiple = 1, average specialty
in the moderate training sector

VII. COST EFFECTIVENESS OF ALTERNATIVE MANAGEMENT ACTIONS

This section uses the ALEC model to find the cost effectiveness of all the management actions listed in Sec. III, for average specialties in the low, moderate, and high training sectors.

Cost effectiveness is measured relative to NPS accessions for a four-year term of enlistment. Results are reported for values of experience ranging from 0 (no value to experience) to 2 (productivity increases with experience twice as fast as pay increases with experience).

Whether a small cost effectiveness index is good or bad depends upon whether the action increases or decreases the force. When increasing the force, the objective is to obtain the additional effectiveness at the smallest possible cost. So for actions that increase the force, a small cost effectiveness ratio is good. However, when decreasing the force, the objective is to obtain as much savings as possible in return for the lost effectiveness. So, for actions that decrease the force, a large cost effectiveness ratio is good.

The section first compares the performance of management actions for the average specialty in the moderate training sector. Figures of the results presented in a parallel format make comparisons of the different management actions easy. Then the section shows how moving from the moderate training sector to the low or high training sectors affects the results.

COST EFFECTIVENESS IN THE MODERATE-TRAINING SECTOR

Figures 7.1 through 7.10 compare the performance of management actions that increase the force, for the average specialty in the moderate-training sector. The top graph on each page shows the distribution of the additional trained-person-years generated by the management action. These distributions show the relative seniority of the personnel added to the enlisted force by a particular action. They also provide a rough indication of the number of years between the time an action is taken and the time it affects the enlisted force.
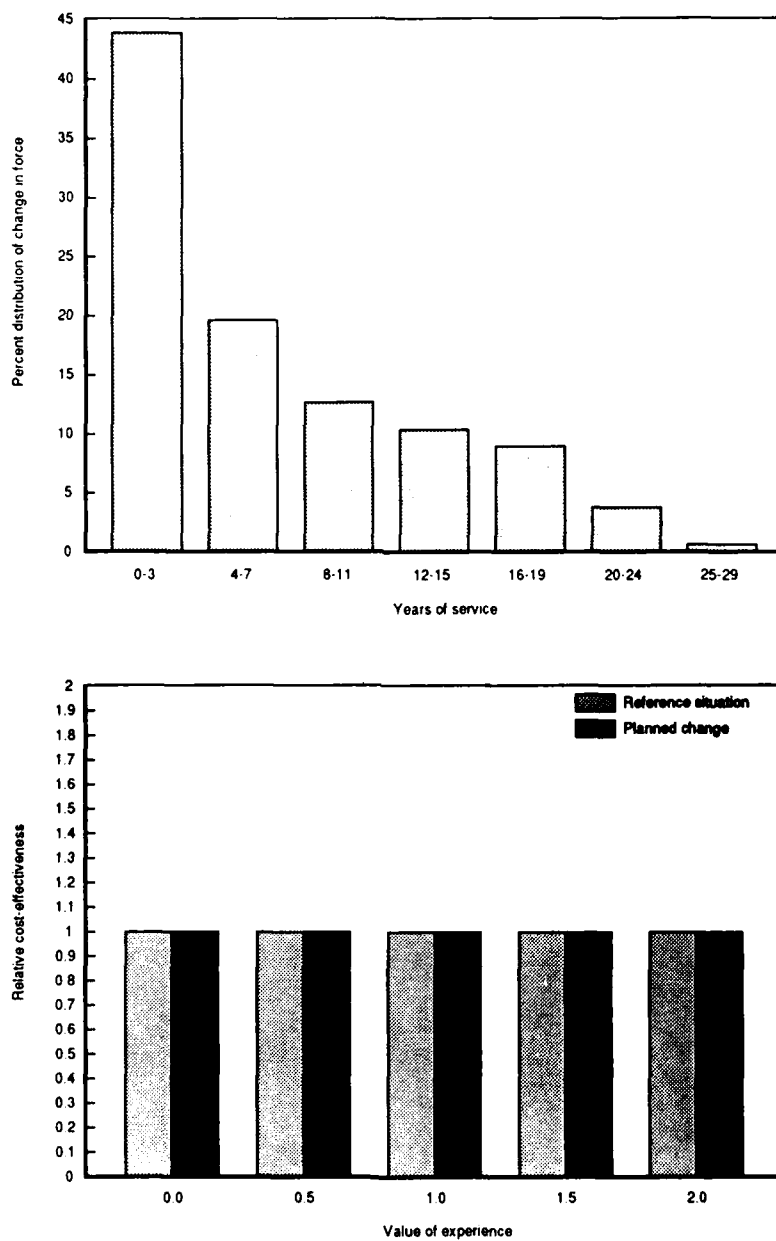
Fig. 7.1 -- NPS accessions with a four-year TOE, average specialty
in the moderate training sector
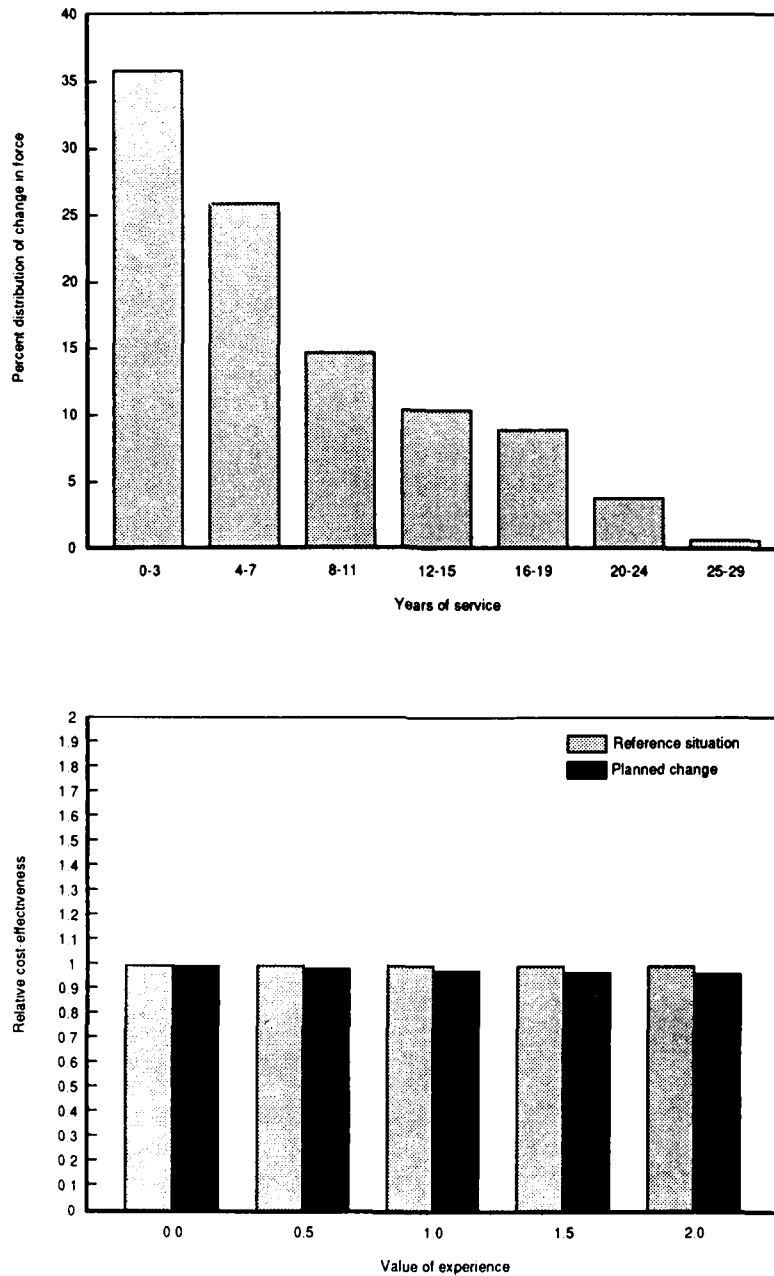
Fig. 7.2 -- NPS accessions with a six-year TOE, average specialty
in the moderate training sector

Fig. 7.3 -- PS accessions with no retraining, average specialty
in the moderate training sector

Fig. 7.4 -- PS accessions with retraining, average specialty
in the moderate training sector

Fig. 7.5 -- Retraining-in at YOS = 4, average specialty
in the moderate training sector

Fig. 7.6 -- Retraining-in at YOS = 8, average specialty
in the moderate training sector

Fig. 7.7 -- Retraining in at YOS = 12, average specialty
in the moderate training sector

Fig. 7.8 -- Zone A bonus multiple = 1, average specialty
in the moderate training sector

Fig. 7.9 -- Zone B bonus multiple = 1, average specialty
in the moderate training sector
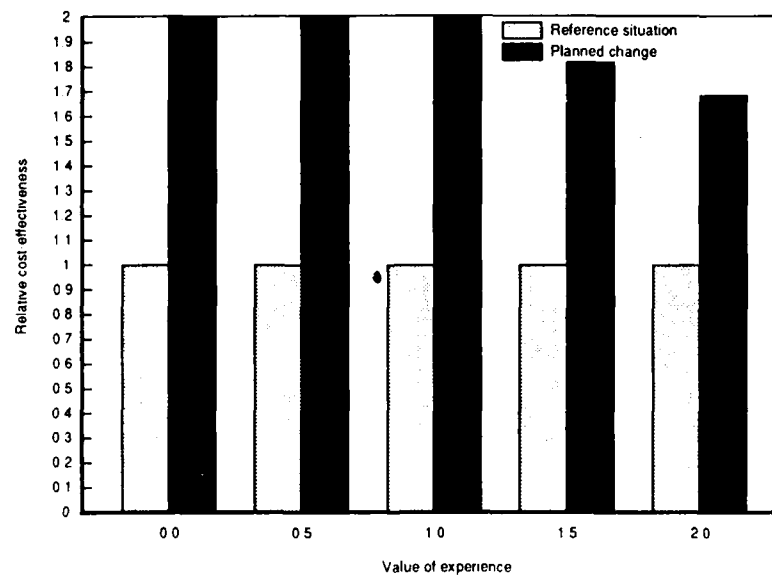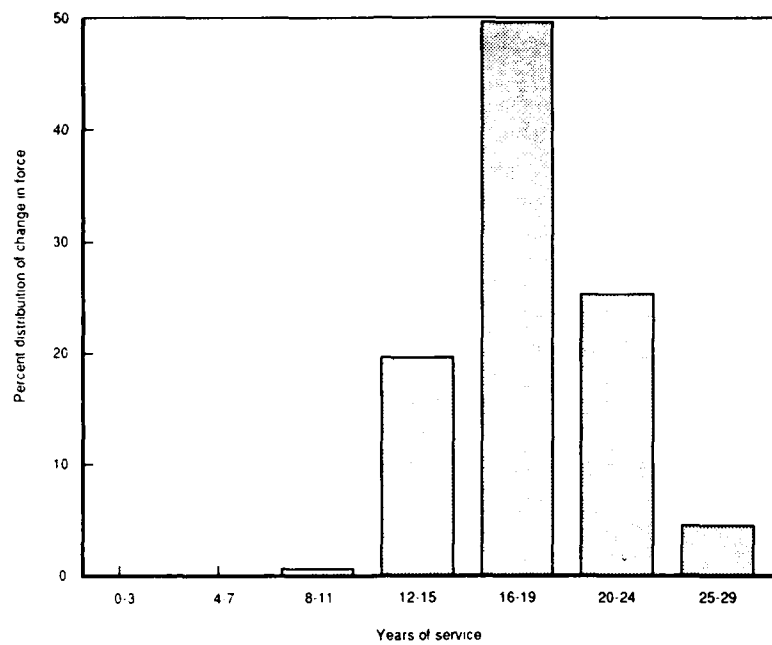
Fig. 7.10 -- Zone C bonus multiple = 1, average specialty
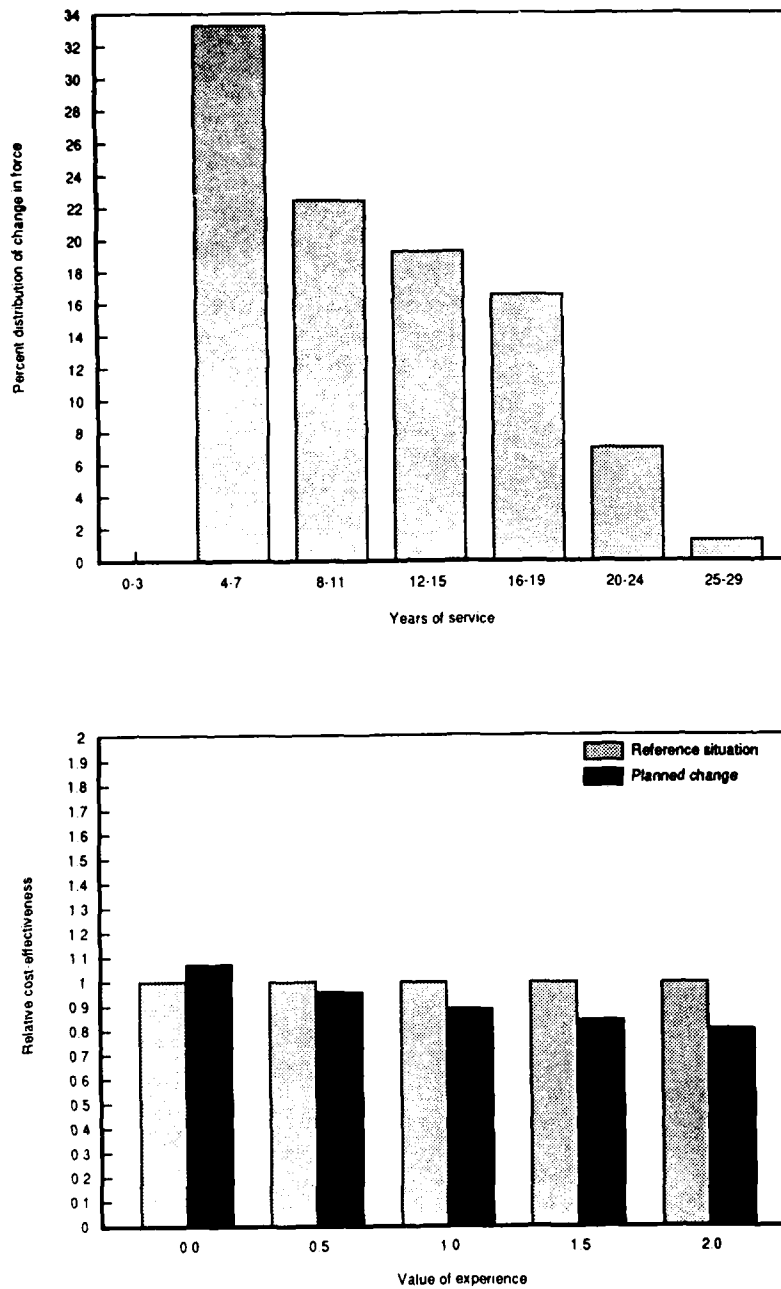in the moderate training sector

Note that the force distributions for the reenlistment bonus actions are more senior than the force distributions for the comparable retraining-in actions. For example, the zone A bonus adds more trained-person-years in the YOS = 8-11 range than it does in the YOS = 4-7 range, while retraining-in at YOS = 4 has the opposite pattern (see Figs. 7.5 and 7.8).

The relative seniority of the additional trained-person-years caused by a reenlistment bonus is the result of the term-of-enlistment effect. Reenlistment bonuses not only increase reenlistments into a specialty but they also increase the term of enlistment, and the additional trained-person-years generated do not occur until four years after the bonus is offered.

The bottom graph on each page shows the cost effectiveness of the action relative to that of increasing the force with NPS accessions for a four-year term of enlistment. For actions that increase the force, a small cost effectiveness ratio is best. For example, a cost effectiveness ratio of 0.9 means that the additional effectiveness caused by the management action costs 10 percent less than if the additional effectiveness had been obtained by increasing accessions.

Figures 7.11 through 7.17 compare the performance of management actions that decrease the force, for the average specialty in the moderate training sector. The top graph on each page shows the distribution of the reduction in trained-person-years generated by the management action, and the bottom graph shows the cost effectiveness of the action relative to that of decreasing the force with NPS accessions for a four-year term of enlistment.

Remember that for actions that decrease the force a large cost effectiveness ratio is best. For example, a cost effectiveness ratio of 1.1 means that the reduction in effectiveness caused by the management action saves 10 percent more than if the subtracted effectiveness had been obtained by decreasing accessions.
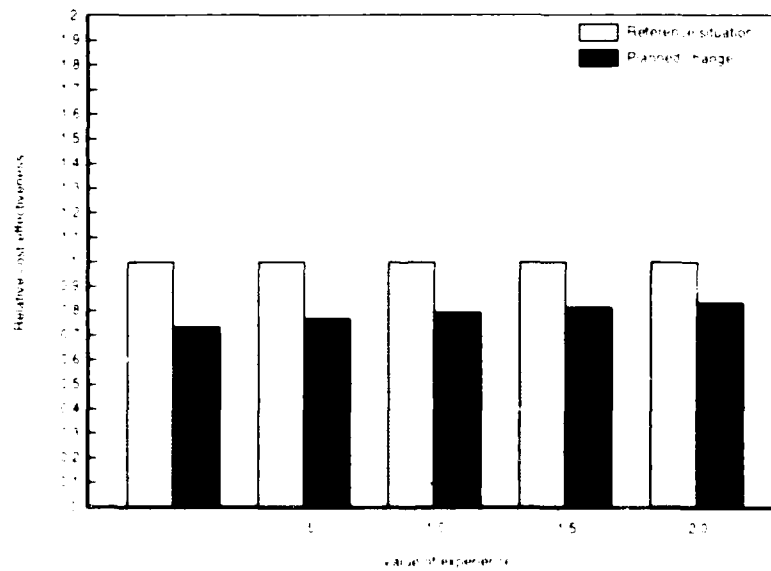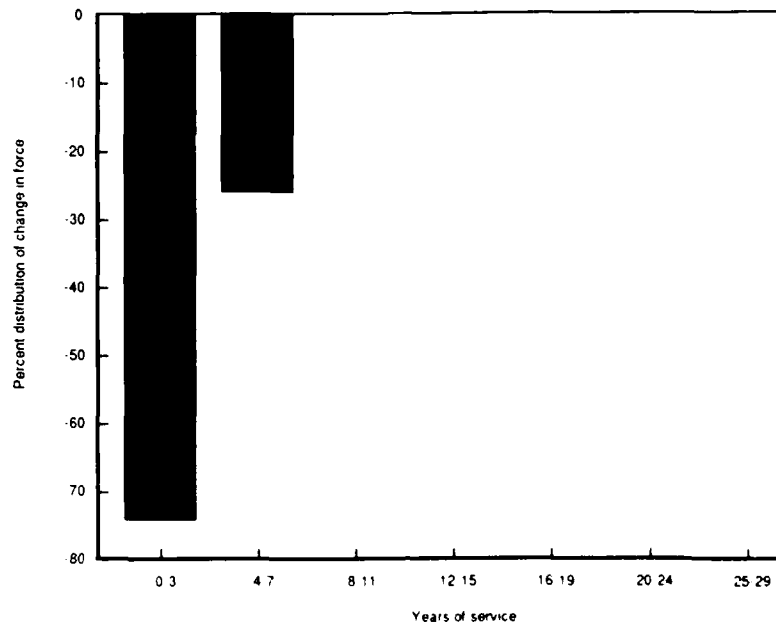
Fig. 7.11 -- Early release from the first term, average
specialty in the moderate training sector
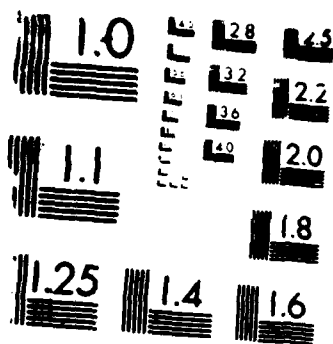
MICROCOPY RESOLUTION TEST CHART
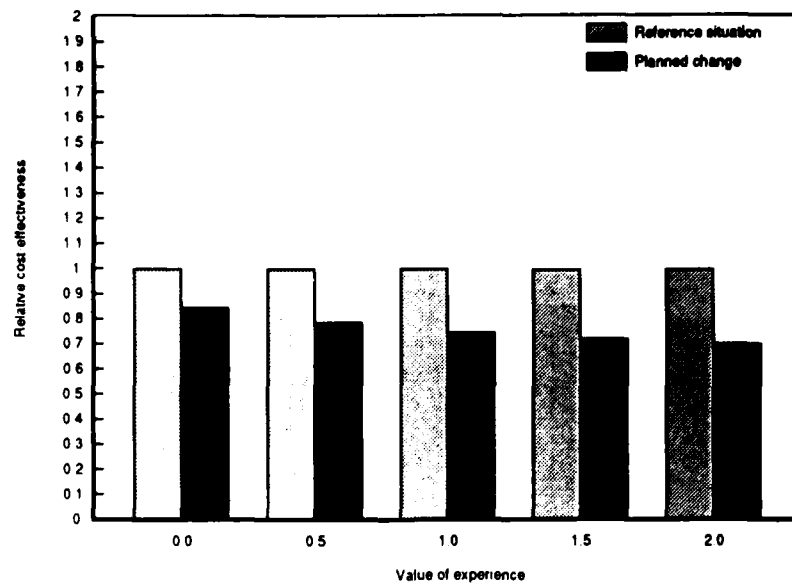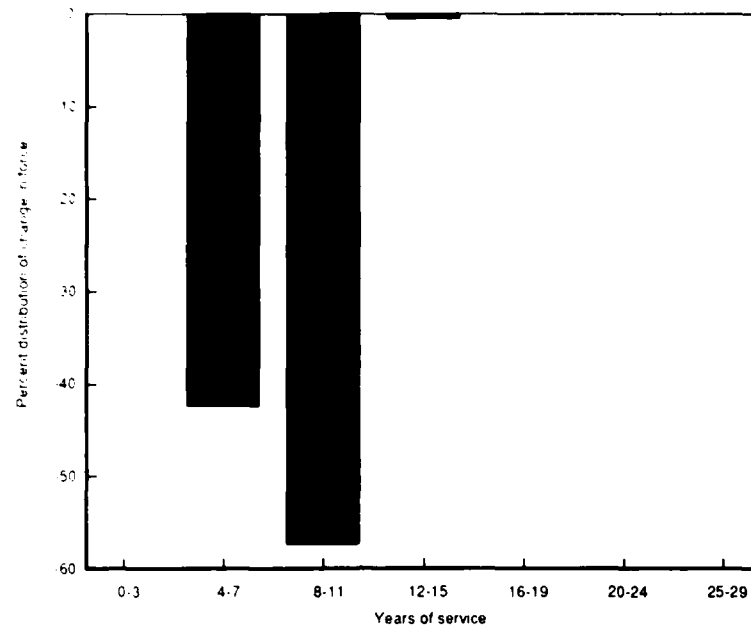
Fig. 7.12 -- Early release from the second term, average
specialty in the moderate training sector
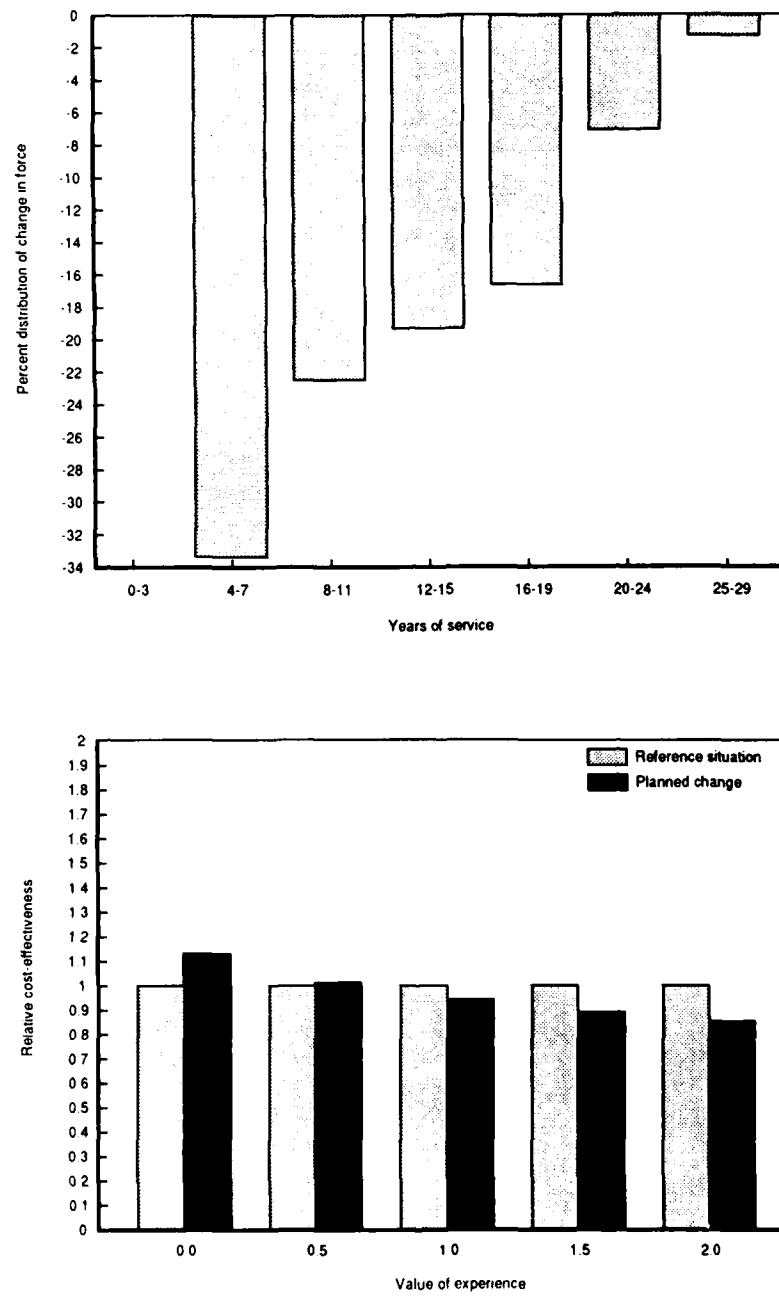
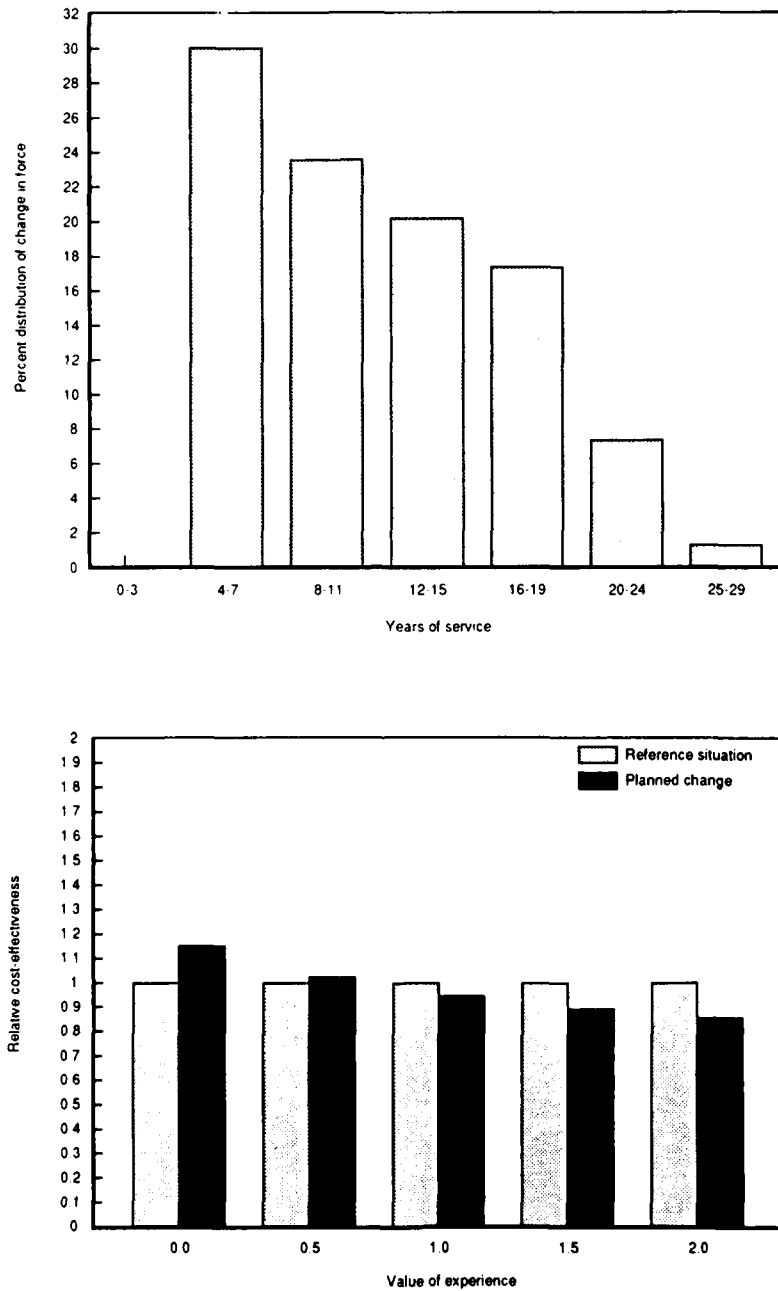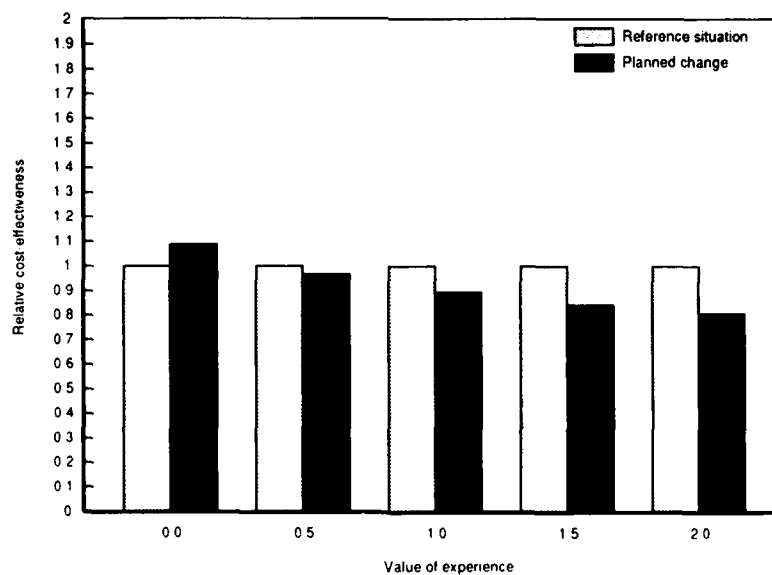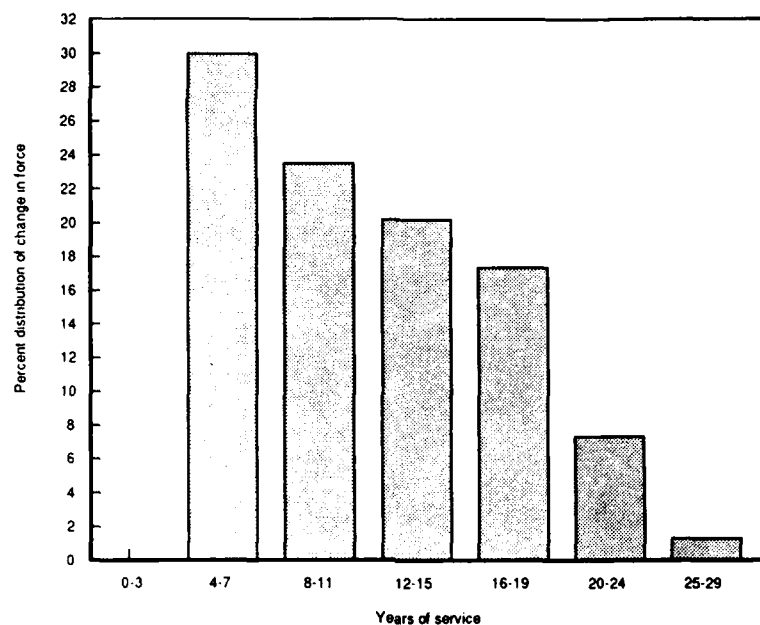Fig. 7.13 -- Retrain-out at YOS = 4, average specialty
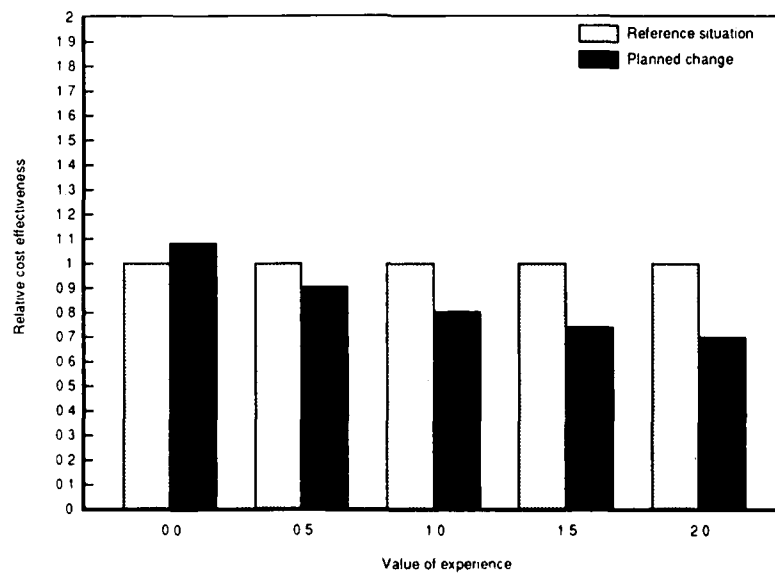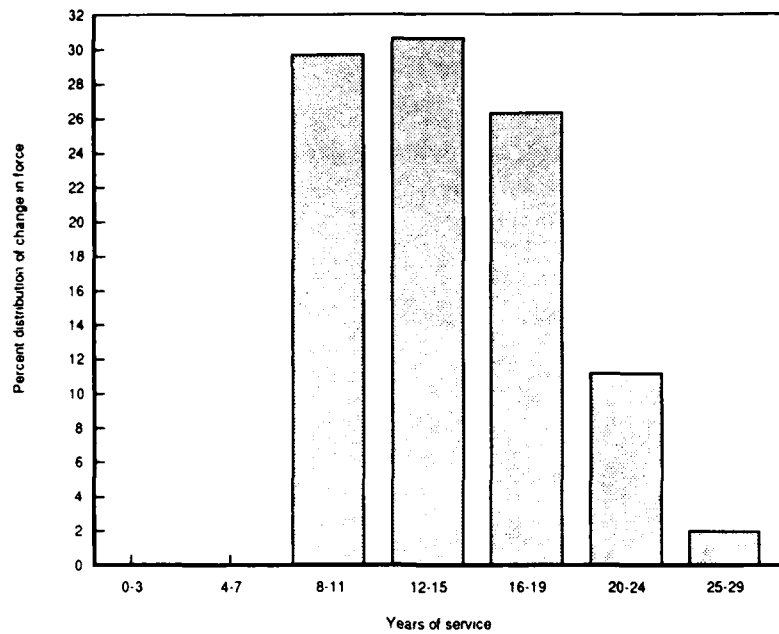in the moderate training sector
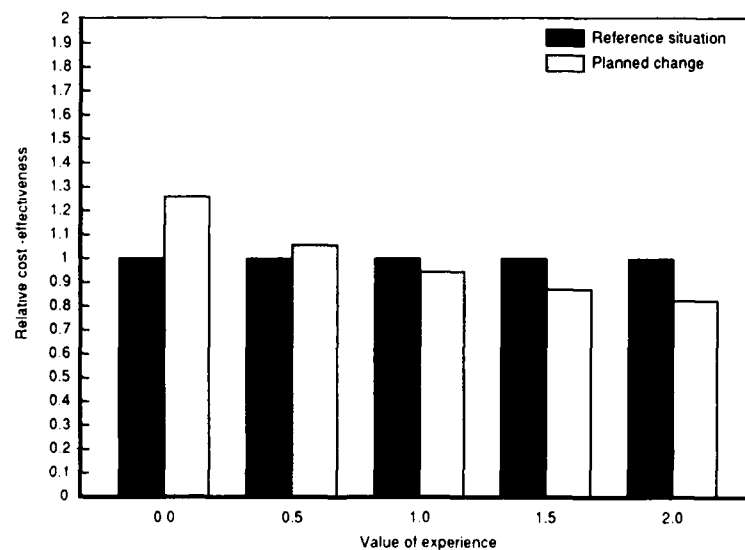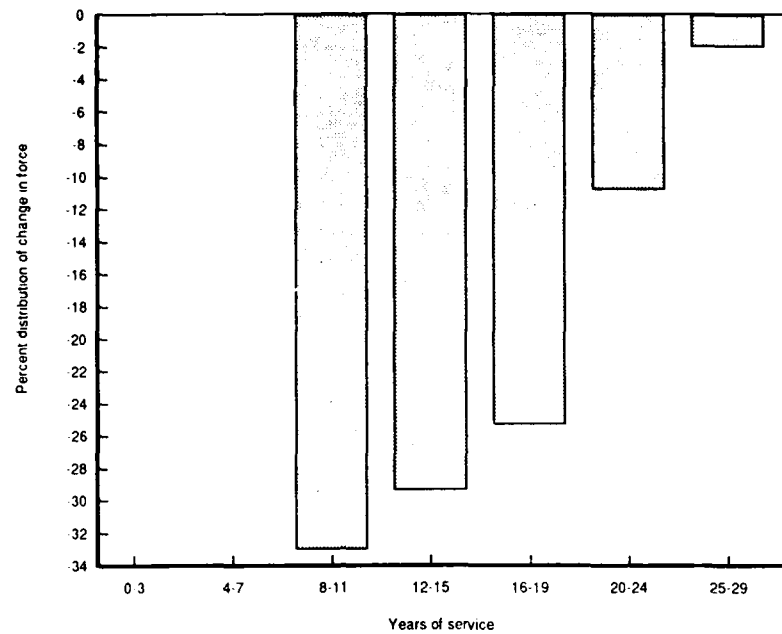
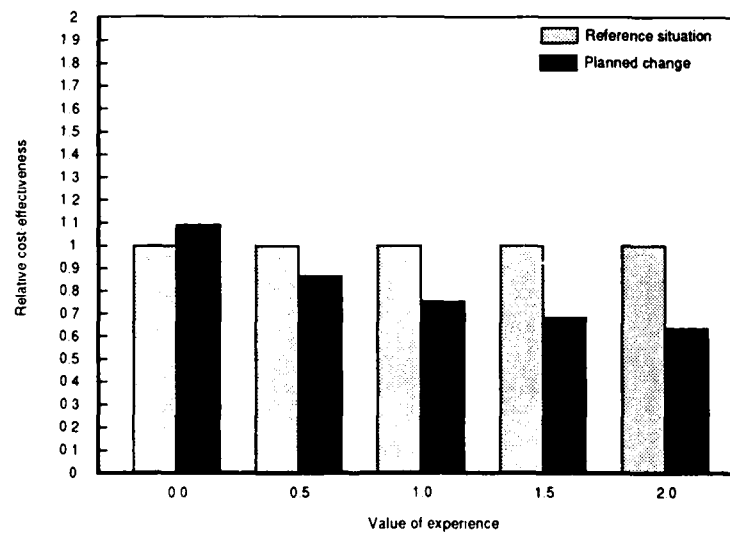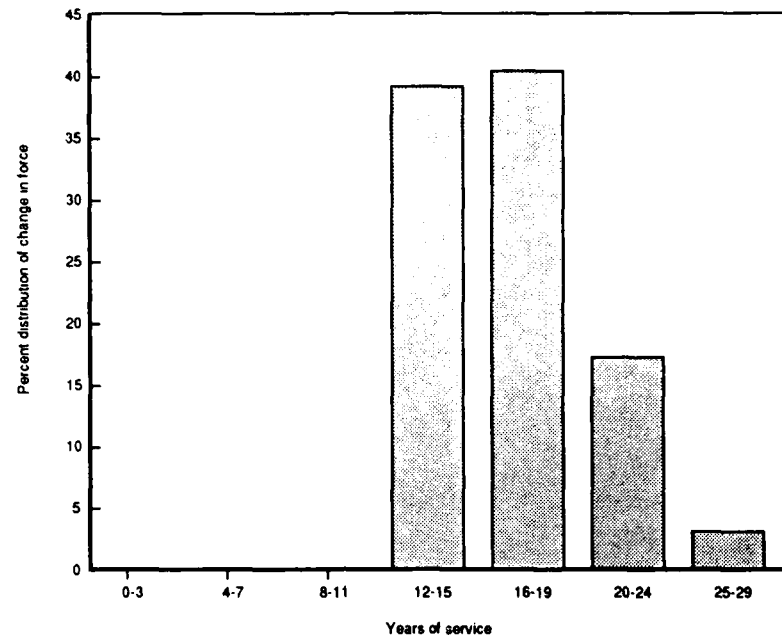Fig. 7.14 -- Retrain-out at YOS = 8, average specialty
in the moderate training sector
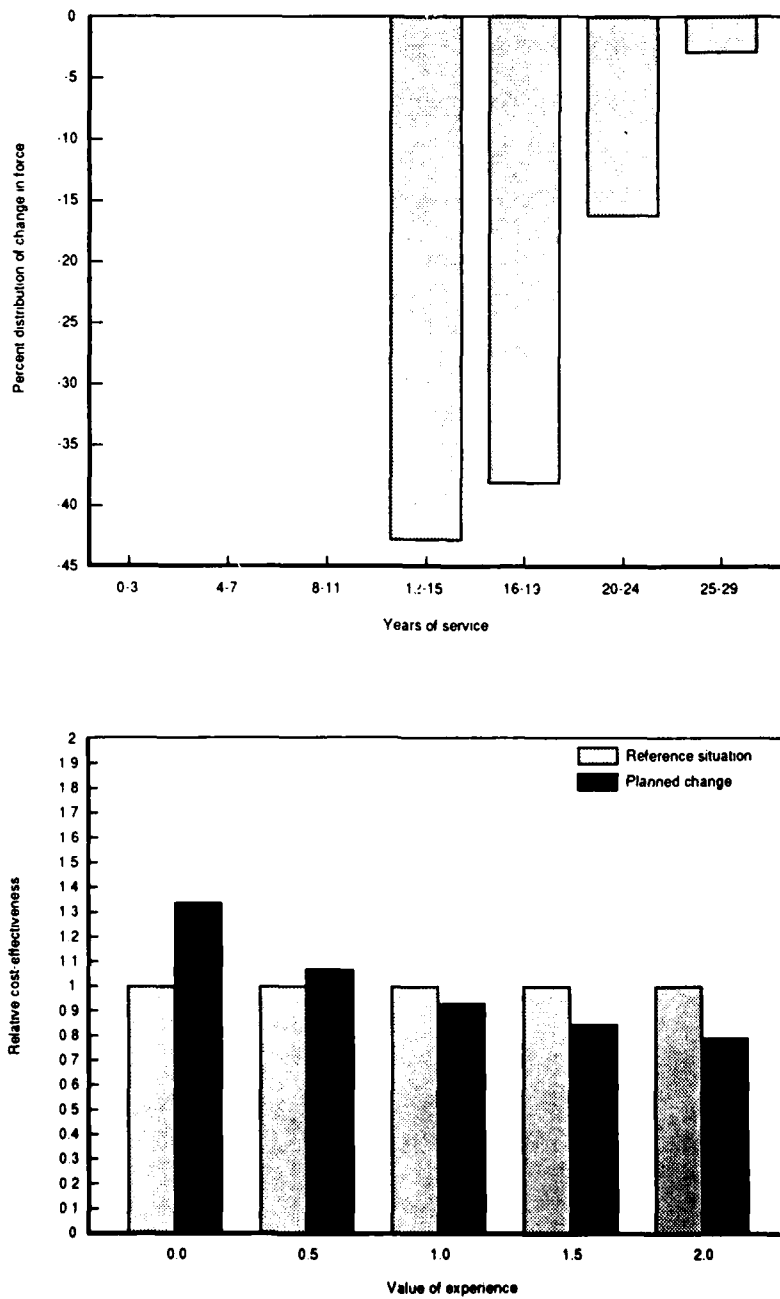
Fig. 7.15 -- Retrain-out at YOS = 12, average specialty
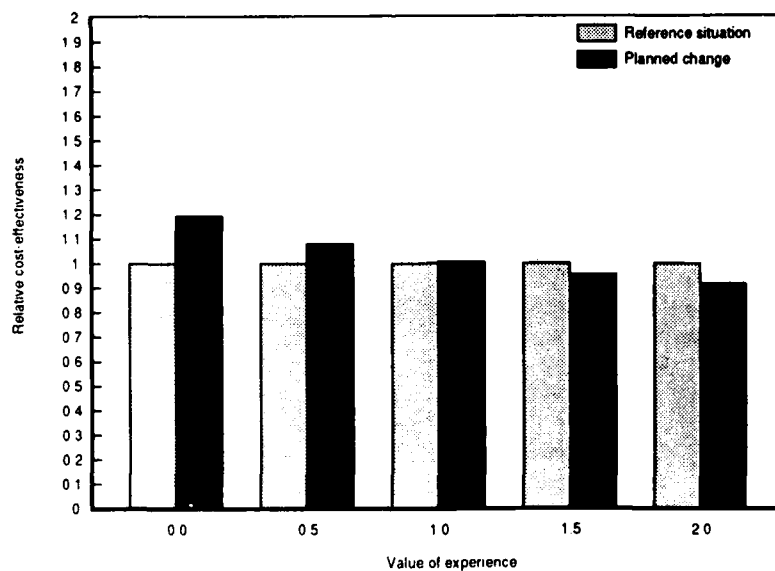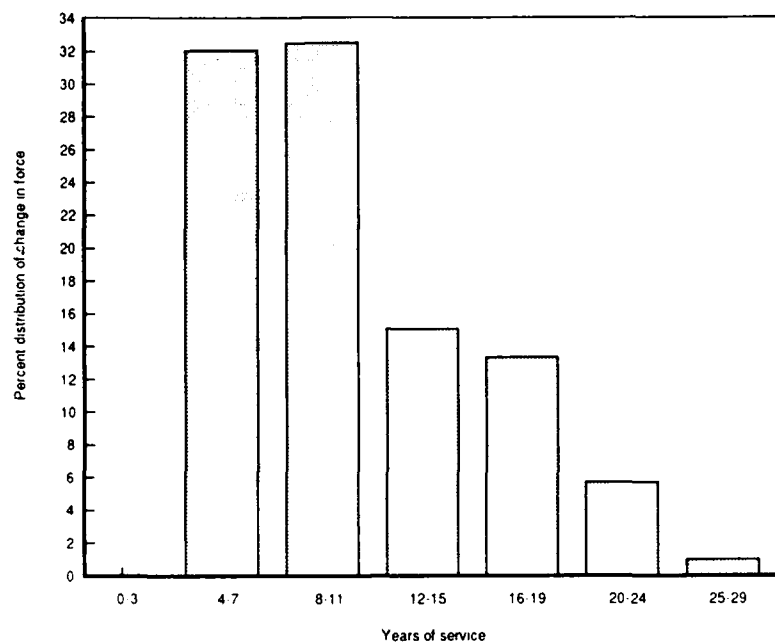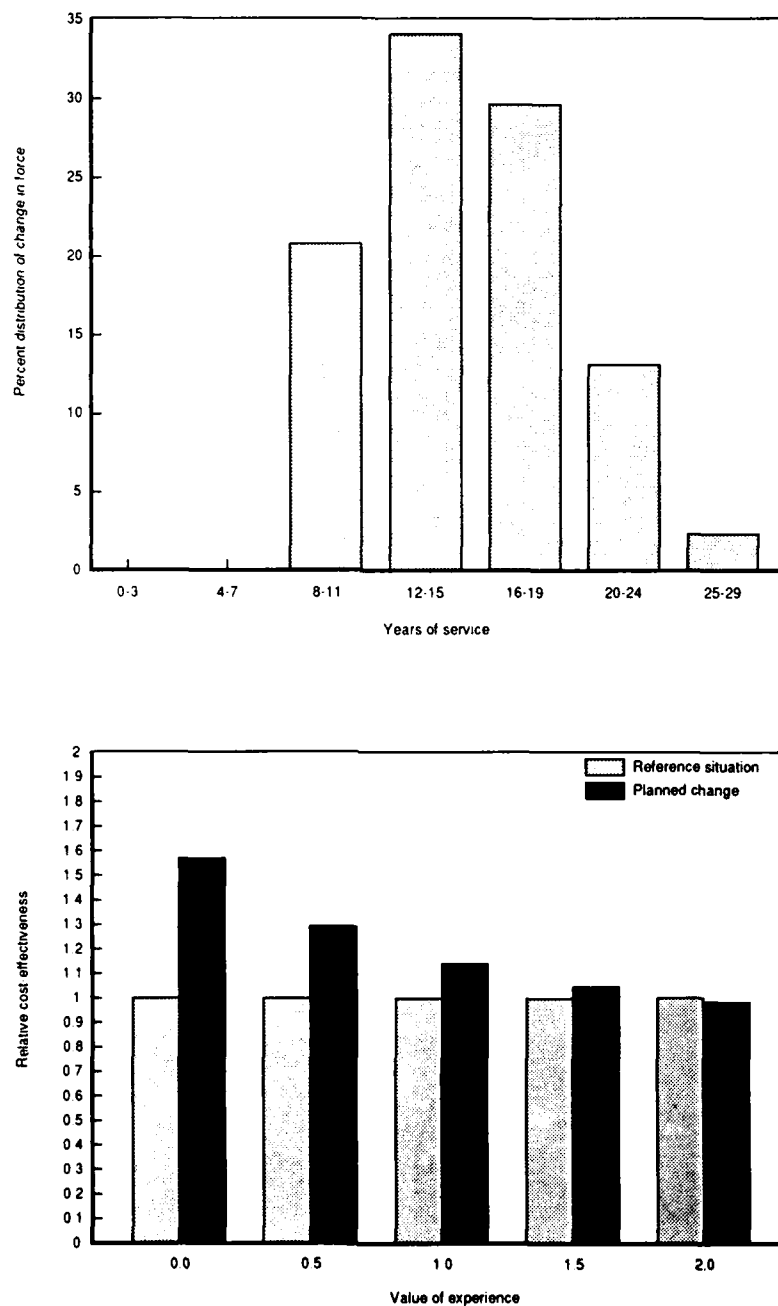in the moderate training sector
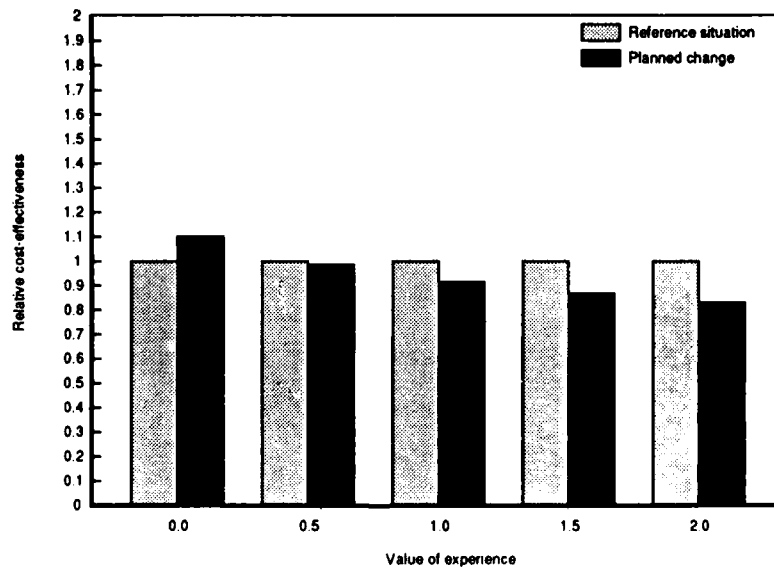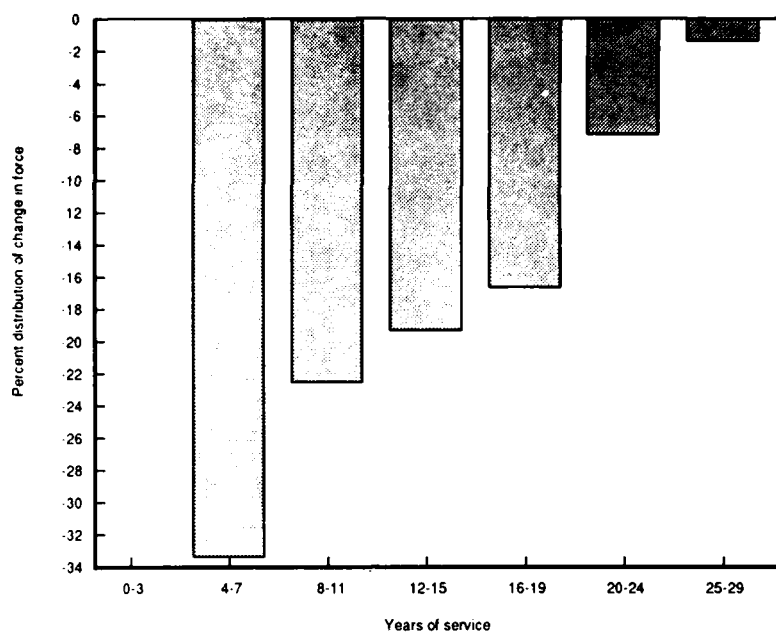
Fig. 7.16 -- CJRs on own reenlistments, average specialty
in the moderate training sector
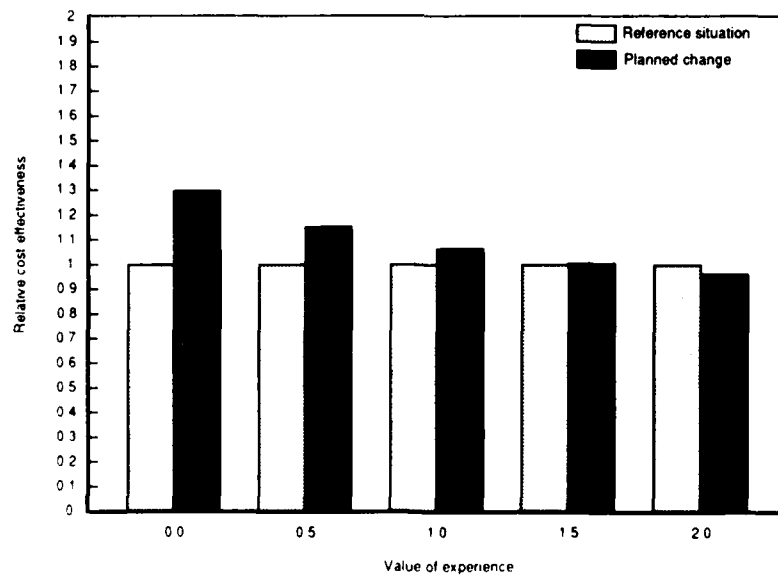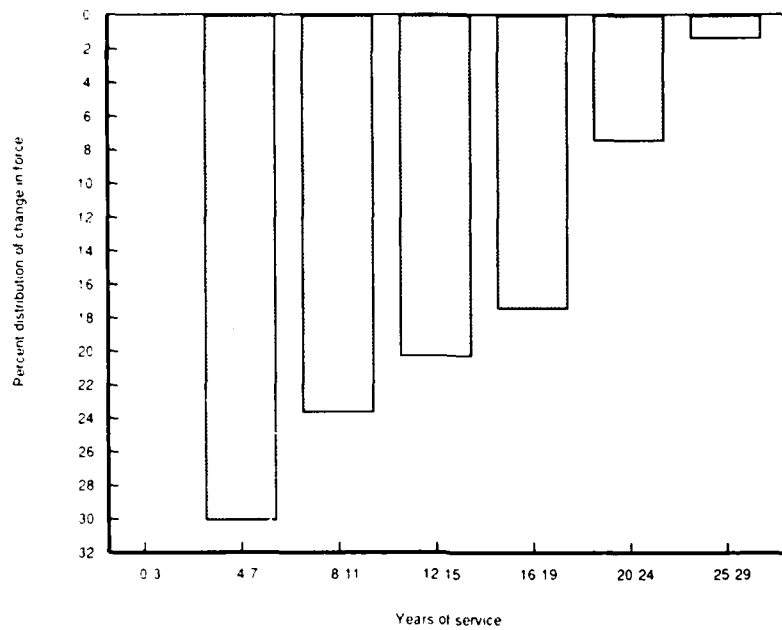
Fig. 7.17 -- CJRs on other reenlistments, average specialty
in the moderate training sector

COMPARISON WITH THE LOW AND HIGH TRAINING SECTORS

Tables 7.1 through 7.3 present the cost effectiveness ratios for all management actions for the average specialties in the low, moderate, and high training sectors. Users of ALEC can get an approximate preview of the results for a particular specialty by finding the sector in which that specialty falls (see App. A) and then looking at the appropriate one of these three tables. The results for the low training sector can be used as a guide to results for specialties in the support sector, because the low training and support sectors have similar characteristics.

Table 7.1

COST EFFECTIVENESS OF MANAGEMENT ACTIONS:
LOW TRAINING SECTOR

	Value of Experience		
Management Action	0	1	2
Actions that Increase the Force (low ratios are best)			
Accessions:			
Non Prior Service, four-Year TOE	1.00	1.00	1.00
Non Prior Service, 6-Year TOE	1.00	1.00	.99
Prior Service, no retraining	1.12	.92	.83
Prior Service, with retraining	1.18	.96	.86
Retraining into a Specialty:			
At 4 years of service	1.11	.90	.81
At 8 years of service	1.11	.81	.70
At 12 years of service	1.12	.76	.64
Selective Reenlistment Bonuses:			
Zone A	1.24	1.03	.93
Zone B	1.63	1.16	.99
Zone C	3.09	2.01	1.65
Actions that Decrease the Force (high ratios are best)			
Early Release:			
First Term	.78	.83	.86
Second Term	.89	.78	.72
Retraining out of a Specialty:			
At 4 years of service	1.19	.97	.88
At 8 years of service	1.32	.98	.84
At 12 years of service	1.41	.96	.81
Career Job Reservations			
For Own Reenlistments	1.15	.95	.85
For Inflow Reenlistments	1.33	1.09	.98

NOTE: Cost effectiveness of an action measured relative to the cost effectiveness of NPS accessions with a four-year TOE.

Table 7.2

COST EFFECTIVENESS OF MANAGEMENT ACTIONS:
MODERATE TRAINING SECTOR

Management Action	Value of Experience		
	0	1	2
Actions that Increase the Force (low ratios are best)			
Accessions:			
Non Prior Service, four-Year TOE	1.00	1.00	1.00
Non Prior Service, 6-Year TOE	1.00	.98	.97
Prior Service, no retraining	1.07	.89	.81
Prior Service, with retraining	1.15	.95	.86
Retraining into a Specialty:			
At 4 years of service	1.09	.89	.81
At 8 years of service	1.08	.81	.70
At 12 years of service	1.09	.75	.64
Selective Reenlistment Bonuses:			
Zone A	1.20	1.01	.92
Zone B	1.57	1.14	.98
Zone C	3.05	2.02	1.68
Actions that Decrease the Force (high ratios are best)			
Early Release:			
First Term	.73	.79	.83
Second Term	.84	.75	.70
Retraining out of a Specialty:			
At 4 years of service	1.13	.94	.86
At 8 years of service	1.26	.94	.82
At 12 years of service	1.34	.93	.79
Career Job Reservations			
For Own Reenlistments	1.10	.92	.83
For Inflow Reenlistments	1.30	1.07	.96

NOTE: Cost effectiveness of an action measured relative to the cost effectiveness of NPS accessions with a four-year TOE.

Table 7.3

COST EFFECTIVENESS OF MANAGEMENT ACTIONS:
HIGH TRAINING SECTOR

Management Action	Value of Experience		
	0	1	2
Actions that Increase the Force (low ratios are best)			
Accessions:			
Non Prior Service, four-Year TOE	1.00	1.00	1.00
Non Prior Service, 6-Year TOE	.97	.95	.93
Prior Service, no retraining	.94	.80	.74
Prior Service, with retraining	1.09	.90	.82
Retraining into a Specialty:			
At 4 years of service	1.03	.85	.78
At 8 years of service	1.02	.77	.67
At 12 years of service	1.05	.73	.62
Selective Reenlistment Bonuses:			
Zone A	1.08	.93	.86
Zone B	1.37	1.02	.89
Zone C	2.66	1.79	1.51
Actions that Decrease the Force (high ratios are best)			
Early Release:			
First Term	.65	.72	.77
Second Term	.75	.68	.64
Retraining out of a Specialty:			
At 4 years of service	1.00	.85	.78
At 8 years of service	1.11	.85	.75
At 12 years of service	1.18	.84	.72
Career Job Reservations			
For Own Reenlistments	.97	.83	.76
For Inflow Reenlistments	1.23	1.02	.93

NOTE: Cost effectiveness of an action measured relative to the
cost effectiveness of NPS accessions with a four-year TOE.

VIII. CONCLUSIONS

The theory and behavioral relationships necessary to do cost effectiveness analysis of enlisted force management are now available. That the theory is consistent and the behavioral relationships are complete have been established by construction of the ALEC model. Moreover, that model yields reasonable results, suggesting that the theory and behavioral relationships are correct.

MODELING STRATEGIES

Specific conclusions reached during construction of the ALEC model are:

- A lifecycle perspective is very useful when doing cost effectiveness analysis, because it helps capture all the costs and benefits associated with the management actions used to guide the enlisted force. In particular, the lifecycle perspective makes it easy to handle training costs at the start and retirement benefits at the end of the lifecycle.

- Support costs must be charged to the specialties that they support in order to correctly compare the costs of management actions that require training (and therefore require student support) and those that do not require training.

- Crossflow fees must be paid for inflows to a specialty from other specialties, and received for outflows from a specialty to other specialties, in order to correctly associate all the costs and benefits of a management action with that action.

- Productivity increases with experience powerfully affect the cost effectiveness of most management actions. Conclusions about which actions are more cost effective than others usually require judgments about the value of experience. Those judgments should be easier to make after the ALEC model has shown where the "breakeven" point between two competing management actions lies.

PERFORMANCE OF INDIVIDUAL MANAGEMENT ACTIONS

Users of the ALEC model get to choose the part of the enlisted force to be analyzed. Then in examining the results they get to choose which part of the value of experience range is relevant for that part of the enlisted force.

The illustrative analyses in this Note are not a substitute for specific analyses done in a specific context. However, they do provide a guide to the kinds of results to expect from specific analyses.

Section VII reported cost effectiveness ratios for the average specialties in the low, moderate, and high training sectors. Tables 8.1 through 8.3 in this section reformat this information so that all the results for a particular management action are in one place.

The revised format reveals the situations (if any) in which each management action should be employed. Remember that small ratios are better for actions that increase the force (because they indicate lower costs), and large ratios are better for actions that decrease the force (because they indicate larger savings).

To make the detection of general patterns even easier, Tables 8.4 through 8.6 reduce the cost effectiveness information to a three point scale. "Worse" means that the cost effectiveness of an action in a particular situation is more than 5 percent worse than the cost effectiveness of NPS accessions with a four-year TOE. "Same" means that the cost effectiveness of an action is within ± 5 percent of the cost effectiveness of NPS accessions with a four-year TOE. "Better" means that the cost effectiveness of an action is more than 5 percent better than the cost effectiveness of NPS accessions with a four-year TOE.

General Strategies for Using Management Actions

The results in these tables suggest the following general strategies for making the enlisted force as cost effective as possible:

- Avoid using "Zone C" (third term) reenlistment bonuses to increase the force.

- Avoid using early releases of personnel to accomplish force reductions.

The force increases generated by zone C bonuses cost 1.5 to 3.0 times more than alternative methods of increasing the force; and compared with reducing force size by cutting enlistments, early releases generate only 65 to 85 percent as much savings.

- Use the remaining management actions that increase the force on specialties that have high values of experience, or that have average values of experience and high training requirements.
- Use the remaining management actions that decrease the force on specialties that have low values of experience, or that have average values of experience and low training requirements.

These general conclusions about the performance of management actions that increase and decrease the force apply in particular to management of the zone A reenlistment bonus and CJR actions. These two actions are the major determinants of the career force (post first term force) in a specialty, the first increasing the career force and the second decreasing it.

- Zone A bonuses improve cost effectiveness significantly if a specialty has a high value of experience, or if it has an average value of experience and a high training requirement (see Table 8.2 or Table 8.5).
- Career Job Reservations limiting reenlistments from other specialties improve cost effectiveness significantly if a specialty has a low value of experience, or if it has an average value of experience and a low or moderate training requirement (see Table 8.3 or Table 8.6).

The key point to recognize is that the two programs turn out to be perfect complements. If one program is not called for, then the other one is. Either a specialty should be offered a zone A bonus or it

Table 8.1

COST EFFECTIVENESS OF MANAGEMENT ACTIONS THAT INCREASE THE FORCE:
SIX-YEAR TOE NPS ACCESSIONS AND PS ACCESSIONS

	Value of Experience		
Sector	0	1	2
Non Prior Service Accessions, 6-Year TOE			
Low training	1.00	1.00	.99
Moderate training	1.00	.98	.97
High training	.97	.95	.93
Prior Service Accessions, no retraining			
Low training	1.12	.92	.83
Moderate training	1.07	.89	.81
High training	.94	.80	.74
Prior Service Accessions, with retraining			
Low training	1.18	.96	.86
Moderate training	1.15	.95	.86
High training	1.09	.90	.82

NOTE: Cost effectiveness of an action measured relative
to the effectiveness of NPS accessions with a four-year TOE.

should have its second term enlistments from other specialties limited.
It is obvious that if a zone A bonus is offered to encourage
reenlistments into a specialty such enlistments should not at the same
time be limited. However, it is not so obvious that if limiting
reenlistments into the second term from other specialties is judged to
be a bad idea, that same judgment implies that zone A bonuses are a good
idea.

Dominance Relationships

Applying the above conclusions requires knowing the values of
experience and the training requirements in particular specialties.
This is not surprising because both value of experience and training
level powerfully affect the cost effectiveness of management actions.

Table 8.2

COST EFFECTIVENESS OF MANAGEMENT ACTIONS THAT
INCREASE THE FORCE: RETRAINING AND BONUSES

	Value of Experience		
Sector	0	1	2

Retraining In, YOS = 4

Low training	1.11	.90	.81
Moderate training	1.09	.89	.81
High training	1.03	.85	.78

Retraining In, YOS = 8

Low training	1.11	.81	.70
Moderate training	1.08	.81	.70
High training	1.02	.77	.67

Retraining In, YOS = 12

Low training	1.12	.76	.64
Moderate training	1.09	.75	.64
High training	1.05	.73	.62

Zone A Bonus, Multiple = 1

Low training	1.24	1.03	.93
Moderate training	1.20	1.01	.92
High training	1.08	.93	.86

Zone B Bonus, Multiple = 1

Low training	1.63	1.16	.99
Moderate training	1.57	1.14	.98
High training	1.37	1.02	.89

Zone C Bonus, Multiple = 1

Low training	3.09	2.01	1.65
Moderate training	3.05	2.02	1.68
High training	2.66	1.79	1.51

NOTE: Cost effectiveness of an action measured relative
to the cost effectiveness of NPS accessions with a four-
year TOE.

Table 8.3

COST EFFECTIVENESS OF MANAGEMENT ACTIONS
THAT DECREASE THE FORCE

Sector	Value of Experience		
	0	1	2
Early Release, First Term			
Low training	.78	.83	.86
Moderate training	.73	.79	.83
High training	.65	.72	.77
Early Release, Second Term			
Low training	.89	.78	.72
Moderate training	.84	.75	.70
High training	.75	.68	.64
Retraining Out, YOS = 4			
Low training	1.11	.97	.88
Moderate training	1.13	.94	.86
High training	1.00	.85	.78
Retraining Out, YOS = 8			
Low training	1.32	.98	.84
Moderate training	1.26	.94	.82
High training	1.11	.85	.75
Retraining Out, YOS = 12			
Low training	1.41	.96	.81
Moderate training	1.34	.93	.79
High training	1.18	.84	.72
CJR on Own Reenlistments			
Low training	1.15	.95	.85
Moderate training	1.10	.92	.83
High training	.97	.83	.76
CJR on Other Reenlistments			
Low training	1.33	1.09	.98
Moderate training	1.30	1.07	.96
High training	1.23	1.02	.93

Table 8.4

COST EFFECTIVENESS OF MANAGEMENT ACTIONS THAT INCREASE THE FORCE
RELATIVE TO THAT OF INCREASING THE FORCE WITH NPS4 ACCESSIONS:
NPS6 ACCESSIONS AND PS ACCESSIONS

	Value of Experience		
Sector	0	1	2
Non Prior Service Accessions, 6-Year TOE			
Low training	Same	Same	Same
Moderate training	Same	Same	Same
High training	Same	Same	Better
Prior Service Accessions, No Retraining			
Low training	Worse	Better	Better
Moderate training	Worse	Better	Better
High training	Better	Better	Better
Prior Service Accessions, With Retraining			
Low training	Worse	Same	Better
Moderate training	Worse	Same	Better
High training	Worse	Better	Better

NOTE: "Same" means that the cost effectiveness of the action
is within plus or minus 5 percent of the cost effectiveness of
NPS accessions with a four-year term of enlistment.

Table 8.5

COST EFFECTIVENESS OF MANAGEMENT ACTIONS THAT INCREASE THE FORCE
RELATIVE TO THAT OF INCREASING THE FORCE WITH NPS4 ACCESSIONS:
RETRAINING AND BONUSES

	Value of Experience		
Sector	0	1	2

Retraining In, YOS = 4			
Low training	Worse	Better	Better
Moderate training	Worse	Better	Better
High training	Same	Better	Better

Retraining In, YOS = 8			
Low training	Worse	Better	Better
Moderate training	Worse	Better	Better
High training	Same	Better	Better

Retraining In, YOS = 12			
Low training	Worse	Better	Better
Moderate training	Worse	Better	Better
High training	Same	Better	Better

Zone A Bonus, Multiple = 1			
Low training	Worse	Same	Better
Moderate training	Worse	Same	Better
High training	Worse	Better	Better

Zone B Bonus, Multiple = 1			
Low training	Worse	Worse	Same
Moderate training	Worse	Worse	Same
High training	Worse	Same	Better

Zone C Bonus, Multiple = 1			
Low training	Worse	Worse	Worse
Moderate training	Worse	Worse	Worse
High training	Worse	Worse	Worse

Table 8.6

COST EFFECTIVENESS OF MANAGEMENT ACTIONS THAT DECREASE THE FORCE
RELATIVE TO THAT OF DECREASING THE FORCE WITH NPS4 ACCESSIONS

Sector	Value of Experience		
	0	1	2
Early Release, First Term			
Low training	Worse	Worse	Worse
Moderate training	Worse	Worse	Worse
High training	Worse	Worse	Worse
Early Release, Second Term			
Low training	Worse	Worse	Worse
Moderate training	Worse	Worse	Worse
High training	Worse	Worse	Worse
Retraining Out, YOS = 4			
Low training	Better	Same	Worse
Moderate training	Better	Worse	Worse
High training	Same	Worse	Worse
Retraining Out, YOS = 8			
Low training	Better	Same	Worse
Moderate training	Better	Worse	Worse
High training	Same	Worse	Worse
Retraining Out, YOS = 12			
Low training	Better	Same	Worse
Moderate training	Better	Worse	Worse
High training	Same	Worse	Worse
CJR on Own Reenlistments			
Low training	Better	Same	Worse
Moderate training	Better	Worse	Worse
High training	Same	Worse	Worse
CJR on Other Reenlistments			
Low training	Better	Better	Same
Moderate training	Better	Better	Same
High training	Better	Same	Worse

However, some relations between management actions are true for all
values of experience and all training levels. In other words, sometimes
one management action dominates another so that it is better (or at
least the same as the other) under all conditions.

Looking at Tables 8.1 and 8.2 several important dominance
relationships become apparent.

- Prior service accessions without retraining dominates prior
  service accessions with retraining.

The reason is obvious: the savings in retraining costs.

- Retraining into a specialty from other specialties also
  dominates prior service accessions with retraining.

The reason in this case is more complicated: It is not retraining
costs because both actions have them, but rather the crossflow fees
received from the origin specialties. Those crossflow fees recognize
the benefit to the origin specialty of an outflow of personnel (see Sec.
VI).

- Prior service accessions with retraining, in turn, dominate
  zone A bonuses.

This means that having to retrain all second-term enlistments is
less expensive than only having to retrain some of them (the increases
in CAREERS Program flows caused by a zone A bonus) but having to pay
zone A bonuses to all of them.

- Finally, zone A bonuses dominate zone B bonuses, and zone B
  bonuses dominate zone C bonuses.

In this case the reason for the dominance is longer remaining
portions of the cohort's lifecycle over which to amortize the cost of
the reenlistment bonus.

In actions that decrease the force there are two final dominance relationships (see Table 8.3):

- Career Job Reservations on other reenlistments dominate Career Job Reservations on own reenlistments.
- Career Job Reservations on other reenlistments also dominate retrainings-out at YOS 4.

The reason for both dominance relationships is savings in retraining costs. If reenlistments from other specialties decrease, training costs decrease; however, no retraining is necessary to stay in the same specialty, so decreasing own reenlistments or decreasing retrainings-out does not decrease training costs.

EXAMPLE ANALYSES OF MULTIPLE-ACTION PLANS

The analyses in this Note have emphasized on the performance of individual actions. Such analyses are important because only by understanding the performance of individual actions can one design good multiple-action management plans. However, understanding the performance of combinations of actions is the ultimate goal; so it is appropriate to end this presentation with some examples of multiple-action plans.

Two examples will serve to explore the extreme situations. The first example uses management actions that increase the senior force to improve the cost effectiveness of the average specialty in the high training sector under the assumption of a high value of experience. The second example uses management actions that decrease the senior force to improve the cost effectiveness of the average specialty in the low training sector under the assumption of a low value of experience.

In both examples, the reference situation has 10,000 NPS accessions per year for a four-year term of enlistment.[1] All other management actions in the reference situations are equal to zero, except for the Career Job Reservations, which are equal to numbers too large to bind.

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[1] Note that the scale in these examples is not relevant. The conclusions on cost effectiveness remain the same if all flows are multipled by the same factor.

The plans developed for these examples change the force profile considerably but do not change the net present value of the cohort's total cost. With total cost invariant, the only way for cost effectiveness to improve is for effectiveness to increase. In the first example, the plan increases effectiveness by making the force distribution more senior to take advantage of the assumed high value of experience. In the second example, the plan increases effectiveness by making the force distribution more junior to take advantage of the assumed low value of experience.

The example plan for the high training sector has 5000 NPS accessions per year with a six-year TOE, 500 PS accessions without retraining, 500 PS accessions with retraining, 500 retrainings-in at each of YOS 4, 8, and 12, a zone A bonus multiple of 2, and a zone B bonus multiple of 1. This plan uses all the management actions that increase the force except NPS accessions with a four-year TOE and zone C bonuses.

NPS accessions for a four-year term are excluded because for a six-year term they are slightly more cost effective under the assumed circumstances. Zone C bonuses are excluded because they are considerably less cost effective than all other actions in all circumstances.

The example plan for the low training sector has 14000 NPS accessions with a four-year TOE, 1200 retrainings-out at YOS = 4, 150 retrainings-out at YOS = 8, 50 retrainings-out at YOS = 12, and 0 CJRs for reenlistments from other specialties. This plan uses all the management actions that decrease the force except the early release actions and the CJRs for reenlistments from the same specialty.

The early release actions are excluded because they degrade cost effectiveness even under the assumed circumstances of low training requirements and low value of experience. The CJRs on own reenlistments are excluded because they are not as cost effective a method of reducing the force as CJRs on other reenlistments.

Using ALEC to analyze these plans shows that the force distributions under the plans are considerably different from those in the reference situations. For every YOS interval after the first in the

high training sector example, the plan's force distribution is higher than the reference situation's distribution (see Fig. 8.1). In contrast, for every YOS interval after the first in the low training sector example, the plan's distribution is lower than the reference situation's distribution (see Fig. 8.2).

As stated above, the plans have been designed (by iteration) so that in each example the cohort's net-present-value (NPV) total cost is the same for the plan as for the reference situation. However, the cohort's NPV total effectiveness is larger under the plan in both cases.

In the high training sector example, if the value of experience parameter equals 2.0 (indicating that productivity increases twice as fast as pay does with experience) then the plan increases cohort effectiveness by 13 percent. Even if the value of experience parameter is only equal to 1.0 (indicating that productivity increases only as fast as pay does with experience) then the plan still increases cohort effectiveness by 8 percent.

In the low training sector example, if the value of experience parameter equals 0.0 (indicating that productivity does not change at all with experience) then the plan increases cohort effectiveness by 7 percent. Even if the value of experience parameter should be as large as 1.0 (indicating the productivity increases as fast as pay does with experience) then the plan still increases cohort effectiveness by 0.5 percent.
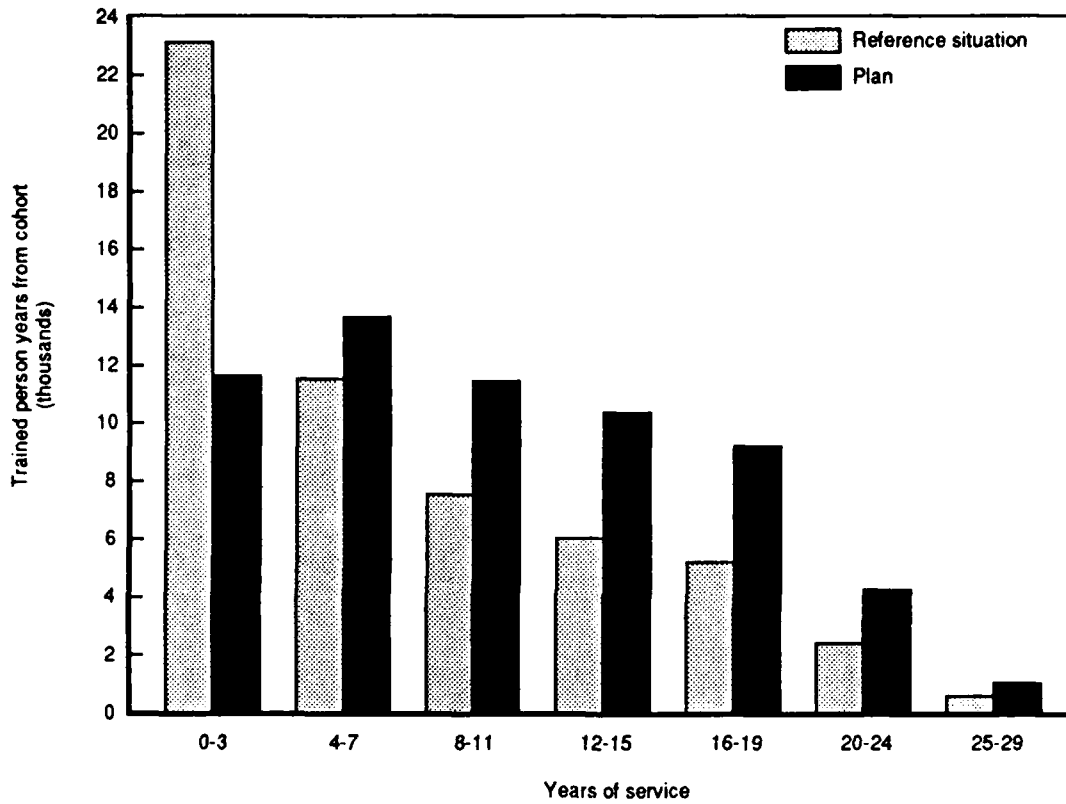
Fig. 8.1 -- Distribution of trained-person-years for the
high training sector example
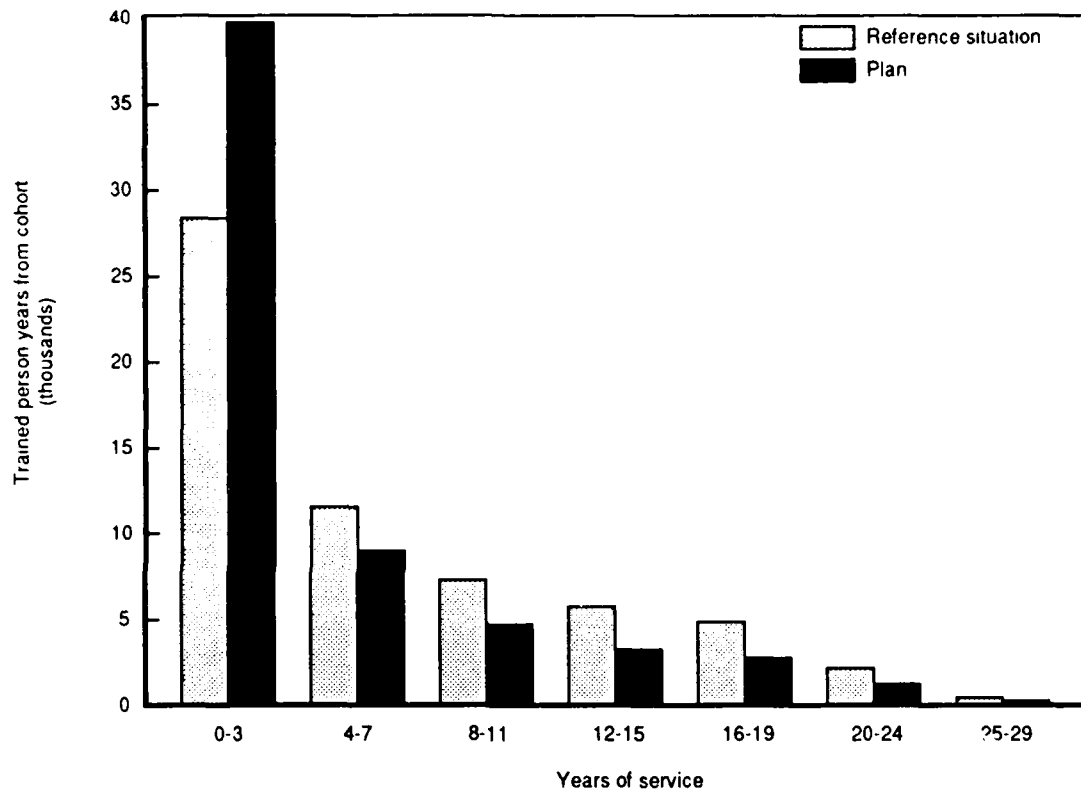
Fig. 8.2 -- Distribution of trained-person-years for the
low training sector example

Appendix A
SECTORS OF THE ENLISTED FORCE

The sectors of the enlisted force used in ALEC were constructed by first dividing Chief Enlisted Manager Progression Groups (CEMPGs) into support and operations categories and then further subdividing the latter by the duration of formal training (BMT plus technical school).

CEMPGs are groups of Air Force Specialty Codes (AFSCs) whose normal career progressions lead to a common chief enlisted manager. The CEMPGs are defined using AFSCs that existed at the end of FY84 (September 30, 1984). Although AFSC details change from year to year, the average characteristics of the sector groups of CEMPGs, and even of most CEMPGs, should remain stable.

CEMPGs are named by the three initial digits of the AFSC of their chief enlisted manager. Often (but not always) all the AFSCs in a CEMPG have those same three initial digits.

CEMPGS IN THE SUPPORT SECTOR

The following CEMPGs are in ALEC's support sector. The list contains those CEMPGs whose personnel levels are assumed by the model to depend on the total number of enlisted persons in the enlisted force.

CEMPG	DESCRIPTION
472	Vehicle Maintenance
602	Traffic
603	Vehicle Operations
605	Air Transportation
611	Services
612	Subsistence
622	Food Service
645	Supply
651	Contracting
661	Logistics Plans
672	Financial
673	Auditing
691	Cost Management Analysis
701	Chapel Management

702	Administration
703	Reprographic
705	Legal Services
732	Personnel Resource
733	Manpower Resource
734	Social Actions
741	Recreation Services
742	Open Mess Management
753	Combat Arms Training and Maintenance
791	Public Affairs
902	Medical Service
905	Pharmacy
906	Medical Administration
912	Optometry
914	Mental Health
915	Medical Material
926	Diet Therapy
981	Dental

CEMPGS IN THE LOW TRAINING SECTOR

Nonsupport CEMPGs whose average duration of formal training is less than or equal to one-fourth of a year (13 weeks) are in the low training sector.

CEMPG	DESCRIPTION
100	First Sergeant
116	Airborne Communications Systems
121	Survival Training
122	Aircrew Life Support
242	Disaster Preparedness
271	Air Operations
274	Command and Control
276	Aerospace Control and Warning System
277	Space Systems Operations
296	Communications-Electronics Programs
297	Radio Frequency
462	Aircraft Armament
511	Computer Systems
551	Pavements and Construction Equipment
552	Structural
554	CE Resources
555	Production Control
566	Sanitation
571	Fire Protection
591	Marine
631	Fuel
811	Security Police

871	Band
872	Instrumentalist
911	Aerospace Physiology
990	Other Reporting Identifiers
995	Other Special Duty Identifiers
996	Other Special Duty Identifiers
997	Other Special Duty Identifiers

CEMPGS IN THE MODERATE TRAINING SECTOR

Nonsupport CEMPGs whose average duration of formal training is more than one-fourth of a year (13 weeks) but less than or equal to one-half a year (26 weeks) are in the moderate training sector.

CEMPG	DESCRIPTION
111	Defensive Aerial Gunner
112	Inflight Refueling
113	Flight Engineer
114	Aircraft Loadmaster
115	Pararescue/Recovery
205	Electronic Intelligence Operations
206	Intelligence Operations
209	Defensive C3CM
222	Geodetic
231	Audiovisual
241	Safety
251	Weather
272	Air Traffic Control
275	Tactical Air Command and Control
291	Telecommunications Operations
391	Maintenance Systems Analysis
392	Maintenance Scheduling
404	Photographic Systems Maintenance
427	Fabrication
432	Aircraft Maintenance
445	Missile Facilities
461	Munitions Maintenance
463	Nuclear Weapons
542	Electrical
545	Mechanical
553	Engineering Assistant
821	Special Investigations
903	Radiologic
907	Bioenvironmental Engineering
908	Environmental Medicine
913	Biomedical Therapy
918	Biomedical Equipment Maintenance
924	Medical Lab

CEMPGS IN THE HIGH TRAINING SECTOR

Nonsupport CEMPGs whose average duration of formal training is more than one-half a year (26 weeks) are in the high training sector.

CEMPG	DESCRIPTION
202	Radio Communications Analyst
203	Linguist/Interrogator
207	Communication Collection System
208	Cryptologic Linguist
273	Combat Control
301	Communication-Electronics Systems
307	Telecommunications Systems Control
316	Missile Electronic Maintenance
324	Precision Measuring Equipment
329	Avionics
341	Training Devices
362	Telephone/Cable and Antenna Maintenance
443	Missile Maintenance
464	Explosive Ordnance Disposal
919	Orthotic
982	Dental Lab
991	Other Reporting Identifiers

SELECTED CHARACTERISTICS OF SECTORS

Both the support and low training sectors have fairly low training times and costs. Compared with those sectors the training times and costs are about half again higher in the moderate training requirement sector and more than double in the high training requirements sector.

The duration of OJT, defined as the time to "level 5 upgrade" after technical school, varies by less than 20 percent across the four sectors.

The percent of initial enlistees with a six-year term of enlistment (TOE) in the low and high training sectors is about twice that in the support and the moderate training requirements sectors.

The fraction of the enlisted force in the four sectors (on September 30, 1984) is approximately one-fourth, one-fourth, one-third, and one-sixth.

Table A.1

SELECTED CHARACTERISTICS OF SECTORS

Characteristic	Sector of the Enlisted Force			
	Support	Low	Moderate	High
Duration of formal training (weeks)	11.9	11.0	15.5	43.8
Cost of formal training (FY84 $)	8313	7062	10107	16443
Duration of OJT (months)	9.39	9.48	10.77	11.23
Initial enlistees with six-year TOE (%)	7.9	20.7	8.0	15.3
Size of sector (% of enlisted force)	26.7	24.1	31.8	17.4

Appendix B
DETAILS OF COHORT BEHAVIOR

This appendix presents details of cohort behavior that are too cumbersome to be included in Sec. IV, but nevertheless are necessary for modeling that behavior.

LOSS AND EXTENSION RATES
Interaction of YOS with the Effect of Variables on Decisions

Table B.1 shows how YOS influences the effect of variables on loss and extension rates. First, bonus zones are defined by YOS ranges. Second, F, a monotonically decreasing function of YOS, is used to taper career effects toward zero as enlisted personnel approach vesting of retirement benefits at YOS = 20.

An example will make the use of F clear. The additive effect of the military/civilian wage ratio on the career ETS decision to leave is

$$[(a16) + (a17)\exp(-(YOS)/2][\ln(\text{mil/civ wage ratio})]$$

where the constraint

$$[(a16) + (a17)\exp(-20/2)] = 0$$

guarantees that the effect will approach zero as the vesting of retirement benefits approaches at YOS = 20 (Carter et al., 1987, Sec. VII).

Using the constraint to solve for a16 in terms of a17, and substituting the result in the first expression, that expression becomes:

$$(a17) \ F \ [\ln(\text{mil/civ wage ratio})]$$

where $F = \exp(-(YOS/2)) - \exp(-10)$

- 111 -

Table B.1

HOW YOS INFLUENCES LOSS
AND EXTENSION RATES

Years of Service (YOS)	Bonus Multiple, M	Tapering Fraction, F
0		0.99995
1		0.60649
2	Zone A	0.36783
3	Zone A	0.22308
4	Zone A	0.13529
5	Zone A	0.08204
6	Zone B	0.04974
7	Zone B	0.03015
8	Zone B	0.01827
9	Zone B	0.01106
10	Zone C	0.00669
11	Zone C	0.00404
12	Zone C	0.00243
13	Zone C	0.00146
14		0.00087
15		0.00051
16		0.00029
17		0.00016
18		0.00008
19		0.00003
20		0.00000

NOTES: The selective reenlistment bonus offered an enlisted person reaching the end of a term of enlistment depends on that person's years of service. The "tapering fraction" is applied to the coefficients in loss and extension equations to model how effects taper off as enlisted persons approach retirement eligibility. The formula for the tapering fraction is $F = \exp(-(YOS/2)) - \exp(-10)$.

Effect of Reenlistment Bonuses on Career Decisions

The effect of reenlistment bonuses on the decision to leave at the career ETS decision point, or career extension year decision points, has not been estimated directly. Rather, the effect has been estimated indirectly through the wage effect.

The method used assumes that a one-multiple reenlistment bonus at a career term decision point is equivalent to a permanent annual pay increase equal to one month's basic pay. One month's basic pay is assumed to equal 2/3 of total pay. Hence, pay is assumed to increase by $(1/12)(2/3) = 1/18$. Consequently, the effect of a reenlistment bonus multiple on a career term decision equals:

(a17) F {ln[(mil/civ wage ratio)(1 + 1/18)] - ln(mil/civ wage ratio)}

For the purposes of this calculation the military/civilian wage ratio is assumed to be 1.0, making ln(mil/civ wage ratio) = 0. So, the effect of a reenlistment bonus multiple on a career term decision simplifies to:

(a17) F ln(1 + 1/18) = (a17) F (0.054067)

where   a17 = mil/civ wage ratio coefficient at a decision
point

Behavior of Extenders

The explanatory variables affect the loss and extension rates of persons who have extended for only one year differently from those that have extended for more than a year.

Extenders for a year or less are said to be in a "decision year" during their first extension year. Their decision is whether to leave or reenlist.

Extenders for more than a year are said to be in an "attrition year" during their first extension year and in a "decision year" in their second extension year. During the attrition year their choices are to leave or extend.

The econometric analysis of the effect of explanatory variables on the behavior of extendees was done separately for attrition years and decision years. This is not a problem in the second extension year, because there everyone is in the decision year. However, in the first extension year, behavior is a weighted average of attrition and decision year behavior:

$$L = P (Ld) + (1 - P) (La) \qquad (B.1)$$

$$E = [P(1 - Ld)(Ed) + (1 - P)(1 - La)(Ea)]/(1 - L) \qquad (B.2)$$

where P = probability that an extension is for less than a year;
L = probability of loss in the first extension year;
E = probability of extension in the first extension year, given not lost;
Ld = probability of loss in a decision year;
Ed = probability of extension in a decision year, given not lost;
La = probability of loss in an attrition year;
Ea = probability of extension in an attrition year, given not lost.

Note that the second equation simplifies to

$$E = (1 - P)(1 - La)/(1 - L) \qquad (B.3)$$

because, by definition of the decision year, Ed = 0, and by definition of the attrition year, Ea = 1.

Then, solving the first equation and the revised second equation for P, we obtain:

$$P = (1 - L)(1 - E)/(1 - Ld) \qquad (B.4)$$

In implementing the econometric findings in Carter et al. (1987), Eq.(B.1) is used to combine the decision year and attrition year loss rate effects into first extension year loss rate effects. Equation (B.4) is used to estimate the probability P from estimates of the constant terms in the equations for first and second extension year behavior.

CAREERS PROGRAM FLOWS

The following estimates are from Carter's econometric analyses for the EFMP's Middle Term Disaggregate IPM.

$K1$ = depends on specialty (see Vol. 2, App. A),

$K2$ = 0.0622,

$K3$ = depends on specialty (see Vol. 2, App. A),

$K4$ = 0.264,

$K5$ = .5.

Equation (4.1), in Sec. IV, and the empirical constants K1 and K2 come directly from the econometric analyses for the Middle-Term Disaggregate IPM. The only change is notation. In the econometric analyses, K1 was called STAYSC (for stay same constant) and K2 was called STAYSB (for stay same bonus coefficient). Similarly, Eqs. (4.10) and (4.11) and the empirical constant K5 come directly from the econometric analyses, except that there K5 was called CLOSSR (for CAREERS Program loss rate of rejected reenlistments).

Equation (4.3) and its empirical constants, K3 and K4, however are an adaptation of the econometric analyses to fit the requirements of lifecycle analyses. The Middle-term Disaggregate IPM models all specialties, so it can model CAREERS reenlistments into specialties by distributing the reenlistments out of specialties. It does this allocation by first accumulating the reenlistments out of specialties

into totals by career field group (five aggregate groupings of Air Force enlisted specialties). Then it models the probability that reenlistments accumlated by career field group k will go to specialty i as:

$$[K6(k,i)] \exp[(K4)B(i)]/ \sum_j \{K6(k,j) \exp[(K4)B(j)]\}$$

In the the econometric analyses, K6(k,i) is called exp(CARCON(k,i)) where CARCON stands for Career constant, and K4 is called CARFBON, where CARFBON stands for Career flow bonuses coefficient.

In applying this econometric result in ALEC two changes have been made. First, the model has been simplifed by removing the bonus effect from the denominator. The simplification is necessary because ALEC analyzes only one part of the force at a time and does not know bonus levels in other specialties. The simplification transforms the model to:

$$K7(k,i) \exp((K4)B(i))$$

where $K7(k,i) = K6(k,i)/ \sum_j \{K6(k,j)\}$

By summing across career field groups we obtain the model used in ALEC, Eq. (4.3):

$$RI = [K3(i)] \exp\{[K4]B(i)\}$$

where $K3(i) = \sum_k \{(\text{Reenlistments in pool k})[K7(k,i)]\}$

The second change from the econometric analysis is that the empirical constant, K3, is modeled in ALEC as a multiple of NPS accessions.

$$K3(i) = [K3a(i)][NPS(i)]$$

where NPS(i) = Non Prior Service accessions in specialty i
       K3a(i) = multiple for specialty i

The reason for this specification is so that ALEC can be operated at any scale (where scale is defined by the NPS accessions that start the lifecycle analysis of a cohort).

The factor, K3a, is estimated by first finding the ratio, X, of the historical annual number of CAREERS reenlistments into a specialty to the total number of people working in that specialty, then finding the ratio, Y, of the typical number of people working in a specialty to the annual number of NPS accessions, and finally setting F = XY.

Appendix C
SENSITIVITY ANALYSES

This appendix explores the sensitivity of ALEC results to two assumptions used in building the model:

Assumption 1: The real discount rate is 4 percent.

Assumption 2: The fraction of time that persons in OJT are not working is 0.4.

The purpose of the sensitivity analyses is twofold. First, we want to make sure that large variations in an assumption *do* change ALEC's results dramatically. Only if the assumption makes a difference is it worth worrying about the exact value that should be used for the assumption. Second, we want to make sure that small variations in an assumption *do not* change ALEC's results dramatically. One can never estimate parameters exactly, so a useful model must not be hypersensitive to small estimation errors.

Both the discount rate and the fraction not worked during OJT display these two properties. In both cases, large variations in the assumption lead to large differences in results; small variations cause only small differences in results.

The sensitivity analysis looks at the cost effectiveness of the Prior Service Without Retraining (PS-no) management action. As usual, that cost effectiveness is measured relative to the cost effectiveness of the Non Prior Service for 4 Years (NPS-4) management action. The PS-no action was chosen for the sensitivity analysis because it is one for which the qualitative effects of the assumptions are particularly easy to predict, so the sensitivity analysis becomes a qualitative as well as quantitative test of ALEC.

EFFECT OF THE DISCOUNT RATE
The larger the discount rate, the smaller the weight given to cost and effectiveness late in the lifecycle relative to cost and

effectiveness early in the lifecycle. The principal difference between PS-no and the NPS-4 management actions is that the latter has the front end cost of training. The larger the discount rate the greater the effect of this front end cost, and therefore the better PS accessions will look relative to NPS accessions. In other words, as the discount rate increases we expect to find that the cost effectiveness ratio of PS-no relative to NPS-4 gets smaller. Table C.1 shows this to be true, indicating that ALEC is performing correctly.

For all three values of experience, large deviations of the discount rate (from the 4 percent used in ALEC) cause large differences in the estimated cost effectiveness ratio; small deviations from 4 percent cause only small differences in the estimated cost effectiveness ratio.

EFFECT OF THE FRACTION OJT NOT SPENT WORKING

The fraction of the OJT period spent learning rather than working does not affect the PS-no action at all, because that action does not generate any OJT training. However, the fraction of the OJT period not spent working does affect the cost effectiveness of the NPS-4 action because that action does generate OJT training. The greater the fraction of OJT spent not working, the smaller the effectiveness generated by an accession, hence the better the PS-no action will look relative to the NPS-4 action.

In other words, as the fraction of OJT not spent working increases we expect to find that the cost effectiveness ratio of PS-no relative to NPS-4 gets smaller. Table C.2 shows this to be true, again indicating that ALEC is performing correctly.

For all three values of experience, large deviations of the fraction of OJT spent not working (from 0.4 used in ALEC) cause large differences in the estimated cost effectiveness ratio; small deviations from 0.4 cause only small differences in the estimated cost effectiveness ratio.

Table C.1

EFFECT OF THE DISCOUNT RATE ON THE COST EFFECTIVENESS
OF NPS ACCESSIONS WITHOUT RETRAINING: AVERAGE
SPECIALTY IN THE MODERATE TRAINING SECTOR

Discount Rate (percent)	Value of Experience		
	0	1	2
0	1.179	0.999	0.923
1	1.149	0.968	0.891
2	1.121	0.939	0.860
3	1.095	0.913	0.833
4	1.071	0.889	0.808
5	1.050	0.868	0.786
6	1.030	0.849	0.766
7	1.013	0.832	0.748
8	0.997	0.817	0.733
9	0.983	0.803	0.718
10	0.970	0.791	0.705

Table C.2

EFFECT OF THE FRACTION OJT NOT SPENT WORKING
ON THE COST EFFECTIVENESS OF NPS ACCESSIONS
WITHOUT RETRAINING: AVERAGE SPECIALTY IN THE
MODERATE TRAINING SECTOR

Fraction OJT Not Spent Working	Value of Experience		
	0	1	2
0.0	1.149	0.942	0.849
0.1	1.130	0.929	0.839
0.2	1.110	0.916	0.829
0.3	1.091	0.902	0.819
0.4	1.071	0.889	0.808
0.5	1.051	0.876	0.798
0.6	1.032	0.863	0.788
0.7	1.012	0.850	0.777
0.8	0.993	0.836	0.767
0.9	0.973	0.823	0.757
1.0	0.953	0.810	0.746

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